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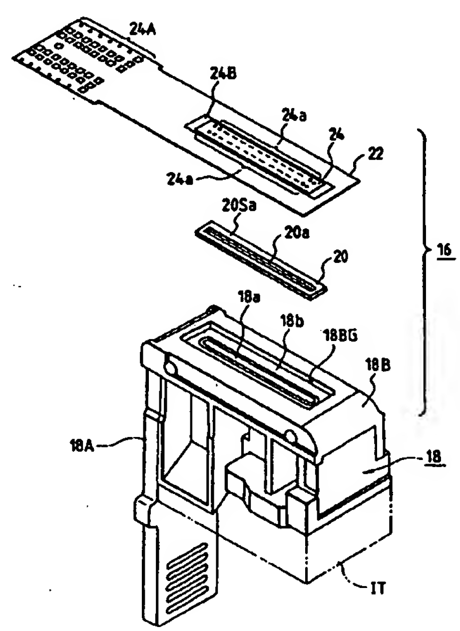
(54) **Ink jet recording head**

(57) An ink jet recording head comprises a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open, a support member having a first joint surface joined to the joined surface in the main body section and a second joint surface disposed opposite to the first joint surface, the support member having a communicating passage in communication with the one end of the ink supply passage, and a recording element board comprising an ink heating portion disposed on the second joint surface of the support member and arranged to heat the ink supplied through the communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed, wherein thermal properties in materials of the recording element board and the support member are of the same quality.

FIG. 1



EP 0 822 078 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an ink jet recording head for ejecting ink to a recording surface of a recording medium to obtain a recorded image thereon.

Related Background Art

There are practically available ink jet recording devices for selectively ejecting ink from a plurality of ink ejection outlets onto the recording surface of recording medium, based on recording data, thereby depositing the ink on the recording surface to form an image. Such ink jet recording devices have an ink jet recording head selectively mounted on a carriage portion, which is disposed opposite to the recording surface of recording medium and which is arranged to undergo scanning in directions perpendicular to the conveying direction of the recording medium.

The ink jet recording head of a side shooter type is comprised, for example as shown in Fig. 25, of main body section 2 consisting of ink supply section 2B, to which ink tank IT is mounted, and input terminal section 2A electrically connected to the carriage portion not illustrated and receiving a drive control signal group from the carriage portion; recording element board 6 joined to a joined surface in the ink supply section 2B of the main body section 2; and printed wiring board 4 electrically connected to the recording element board 6 and supplying the drive control signal group from the input terminal section 2A thereto.

The ink supply section 2B in the main body section 2 is formed, for example, in such a manner that block piece 8 made of an aluminum alloy is integrally molded in a resin, as shown in Fig. 26A. The ink supply section 2B is provided with ink supply passage 2a for guiding the ink from the ink tank IT thereinto. One opening end of the ink supply passage 2a is open in the joined surface 2b including a portion exposed to the outside in the block piece 8.

The recording element board 6 is comprised, as shown in Fig. 26B and Fig. 29, of substrate 10 having ink supply opening portion 10c in communication with the opening end of the ink supply passage 2a in the ink supply section 2B, partition member 12 for forming a plurality of ink branching supply passages 12a provided respectively corresponding to heaters 10a as ink heating portions in the substrate 10, and orifice plate 14 in which a plurality of ink ejection outlets 14a are arrayed in two parallel strings and opposite to the respective heaters 10a in the substrate 10.

The substrate 10 in the recording element board 6 is made of, for example, a silicon material of the thickness of 0.5 to 1.0 mm. Provided in the surface of the substrate 10 bonded to the joined surface 2b of the ink supply section 2B with an adhesive is ink supply opening portion 10c extending in the array direction of the ink ejection outlets 14a and opposite to the orifice plate 14, as shown in Fig. 27A and Fig. 26B.

Further, the heaters 10a are arranged at predetermined mutual intervals on either side of the ink supply opening portion 10c in the substrate 10. One ends of the ink branching supply passages 12a in the partition member 12 are in communication with the ink supply opening portion 10c and each ink branching supply passage 12a is arranged to guide the ink supplied through the ink supply opening portion 10c to the associated heater 10a.

The printed wiring board 4 is electrically connected to each electrode 10b of the substrate 10 in the recording element board 6, as shown in Fig. 29. The printed wiring board 4 has recording element board receiving section 4B in which the recording element board 6 is placed, and terminal section 4A disposed in the input terminal section 2A in the main body section 2.

In this arrangement, when a drive control signal is supplied to each heater 10a of the substrate 10 in the recording element board 6 through the printed Wiring board 4 to heat the heater 10a, the ink introduced through the ink branching supply passages 12a is heated, bubbles are generated therein by the film boiling phenomenon, and with expansion of the bubbles thus generated, the ink is ejected from the ink ejection outlets 14a toward the recording surface of recording medium.

In the arrangement wherein the recording element board 6 in the printed wiring board 4 fixed to the main body section 2 is bonded to the joined surface 2b in the main body section 2 with the adhesive as described above, when the recording element board 6 is excited into the recording operation state as described above, the temperature of the block piece 8 in the joined surface 2b in the main body section 2 increases as the temperature of the recording element board 6 increases. This causes the recording element board 6 and block piece 8 to thermally expand. However, since there is a difference between an expansion coefficient of the recording element board 6 made of silicon and an expansion coefficient of the block piece made of the aluminum alloy, there would occur some cases wherein the recording element board 6 is deformed so that the arrays of ink ejection outlets near the central portion are so curved as to approach each other as deviating from the straight line as shown in Fig. 28, or cases wherein the recording element board 6 is broken. Especially, when a thermosetting adhesive is used, it might be deformed or broken.

In such cases, it is also conceivable to increase the thickness or the surface area in order to enhance the rigidity of the recording element board 6, but it is not wise, because it also increases the manufacturing cost of the recording element board 6.

SUMMARY OF THE INVENTION

In consideration of the above problem, an object of the present invention is to provide an ink jet recording head for ejecting the ink to the recording surface of recording medium to obtain the recorded image thereon, wherein, in bonding fixation of the recording element board to the main body section, the recording element board is prevented from breaking with change in the temperature of the recording element board, without increasing the manufacturing cost of the recording element board.

For achieving the above object, an ink jet recording head according to the present invention is an ink jet recording head comprising: a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open; a support member having a first joint surface joined to the joined surface in the main body section and a second joint surface disposed opposite to the first joint surface, the support member having a communicating passage in communication with the one end of the ink supply passage; and a recording element board comprising an ink heating portion disposed on the second joint surface of the support member and arranged to heat the ink supplied through the communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed; wherein thermal properties in materials of the recording element board and the support member are of the same quality.

Another ink jet recording head according to the present invention is an ink jet recording head comprising: a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open; a first support member having a first joint surface joined to the joined surface in the main body section and a second joint surface disposed opposite to the first joint surface, the support member having a communicating passage in communication with the one end of the ink supply passage; a second support member joined to the second joint surface of the first support member; and a recording element board comprising an ink heating portion disposed inside the second support member, joined to the second joint surface of the first support member, and arranged to heat the ink supplied through the communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed.

A further ink jet recording head according to the present invention is an ink jet recording head comprising: a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open; a first support member having a first joint surface joined to the joined surface in the main body section and a second joint surface disposed opposite to the first joint surface, the support member having a communicating passage in communication with the one end of the ink supply passage; a second support member joined to the second joint surface of the first support member; and a plurality of recording element boards, each recording element board comprising an ink heating portion disposed inside the second support member, joined to the second joint surface of the first support member, and arranged to heat the ink supplied through the communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed; wherein thermal properties in a material of the first support member and a material of the recording element boards are of the same quality.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded, perspective view to show the first embodiment of the ink jet recording head according to the present invention;

Fig. 2A and Fig. 2B are cross-sectional views in the example shown in Fig. 1;

Fig. 3A, Fig. 3B, and Fig. 3C are perspective views to show other examples of the support member used in the example shown in Fig. 1;

Fig. 4 is an exploded, perspective view to show the second embodiment of the ink jet recording head according to the present invention;

Fig. 5A and Fig. 5B are cross-sectional views in the example shown in Fig. 4;

Fig. 6A and 6B are cross-sectional views to show the third embodiment of the ink jet recording head according to the present invention;

Fig. 7 is an exploded, perspective view to show the fourth embodiment of the ink jet recording head according to the present invention;

Fig. 8A and Fig. 8B are cross-sectional views in the example shown in Fig. 7;

Fig. 9A and Fig. 9B are cross-sectional views to show another example of a frame member used in the example shown in Fig. 7;

Fig. 10A and Fig. 10B are cross-sectional views to show other examples of the frame member used in the example shown in Fig. 7;

Fig. 11 is an exploded, perspective view to show the fifth embodiment of the ink jet recording head according to the present invention;

Fig. 12A and Fig. 12B are cross-sectional views in the example shown in Fig. 11;

Fig. 13 is an exploded, perspective view to show the sixth embodiment of the ink jet recording head according to the present invention;

Fig. 14 is a perspective view to show the sixth embodiment of the ink jet recording head according to the present invention;

Fig. 15 is a drawing used for explanation of the operation in the example shown in Fig. 13;

Fig. 16 is a drawing used for explanation of the operation in the example shown in Fig. 13;

Fig. 17 is a plan view of the ink jet recording head in the example shown in Fig. 13;

Fig. 18 is a drawing used for explanation of the operation in the example shown in Fig. 13;

Fig. 19 is a cross-sectional view to show the major part in the example shown in Fig. 13;

Fig. 20 is a cross-sectional view to show the major part in the example shown in Fig. 13;

Fig. 21 is a partial cross-sectional view used for explanation of the operation in the example shown in Fig. 13;

Fig. 22 is a partial cross-sectional view to show another example of the support member used in the example shown in Fig. 13;

Fig. 23 is a partial cross-sectional view used for explanation of the operation in the example shown in Fig. 13;

Fig. 24 is a partial cross-sectional view to show still another example of the support member used in the example shown in Fig. 13;

Fig. 25 is a perspective view to show the conventional apparatus;

Fig. 26A and Fig. 26B are partial cross-sectional views in the example shown in Fig. 25;

Fig. 27A and Fig. 27B are plan views to show the recording element board in the conventional apparatus;

Fig. 28 is a plan view used for explanation of the operation of the recording element board in the conventional apparatus;

Fig. 29 is a perspective view to show the printed wiring board used in the apparatus shown in Fig. 25;

Fig. 30 is an exploded, perspective view to show the seventh embodiment of the ink jet recording head according to the present invention;

Fig. 31A and Fig. 31B are complete assembly diagrams of the ink jet recording head shown in Fig. 30, wherein Fig. 31A is a perspective view of the appearance and Fig. 31B is a partially enlarged view of a cross section along 31B-31B shown in Fig. 31A;

Fig. 32 is a drawing to show the eighth embodiment of the ink jet recording head according to the present invention;

Fig. 33A and Fig. 33B are complete assembly diagrams to show the ninth embodiment of the ink jet recording head according to the present invention, wherein Fig. 33A is a perspective view of the appearance and Fig. 33B is a partially enlarged view of a cross section along 33B-33B shown in Fig. 33A;

Fig. 34 is an exploded, perspective view to show the tenth embodiment of the ink jet recording head according to the present invention;

Fig. 35A and Fig. 35B are complete assembly diagrams of the ink jet recording head shown in Fig. 34, wherein Fig. 35A is a perspective view of the appearance and Fig. 35B is a partially enlarged view of a cross section along 35B-35B shown in Fig. 35A;

Fig. 36 is an exploded, perspective view to show the eleventh embodiment of the ink jet recording head according to the present invention;

Fig. 37A and Fig. 37B are complete assembly diagrams of the ink jet recording head shown in Fig. 36, wherein Fig. 37A is a perspective view of the appearance and Fig. 37B is a partially enlarged view of a cross section along 37B-37B shown in Fig. 37A;

Fig. 38A and Fig. 38B are complete assembly diagrams to show the twelfth embodiment of the ink jet recording head according to the present invention, wherein Fig. 38A is a perspective view of the appearance and Fig. 38B is a partially enlarged view of a cross section along 38B-38B shown in Fig. 38A;

Fig. 39A, Fig. 39B, and Fig. 39C are drawings to show the thirteenth embodiment of the ink jet recording head according to the present invention, wherein Fig. 39A is a plan view of the support member, Fig. 39B is a cross-sectional view along 39B-39B shown in Fig. 39A, and Fig. 39C is an enlarged view of the cross section along 39B-39B after completion of assembly;

Fig. 40 is an exploded, perspective view of the ink jet recording head according to the fourteenth embodiment of the present invention;

Fig. 41 is a cross-sectional view before assembly of pin and insertion hole according to the fourteenth embodiment of the present invention;

Fig. 42 is a cross-sectional view of the pin and insertion hole after completion of assembly thereof according to the fourteenth embodiment of the present invention;

Fig. 43 is an exploded, perspective view of the ink jet recording head according to the fifteenth embodiment of the present invention;

Fig. 44 is a cross-sectional view before assembly of pin and insertion hole according to the fifteenth embodiment of the present invention;

Fig. 45 is a cross-sectional view of the pin and insertion hole after completion of assembly thereof according to the fifteenth embodiment of the present invention;

Fig. 46 is an exploded, perspective view of the ink jet recording head according to the sixteenth embodiment of the present invention;

Fig. 47 is a cross-sectional view before assembly of pin and insertion hole according to the sixteenth embodiment of the present invention;

Fig. 48 is a top plan view of the pin and insertion hole shown in Fig. 47, observed from the top of the insertion hole;

Fig. 49 is a cross-sectional view of the pin and insertion hole after completion of assembly thereof according to the sixteenth embodiment of the present invention;

Fig. 50 is a schematic, perspective view of the ink jet recording head according to the conventional technology; and

Fig. 51 is a cross-sectional view of pin and insertion hole after completion of assembly thereof according to the conventional technology.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Embodiment 1)

Fig. 1 schematically shows the major part of the first embodiment of the ink jet recording head according to the present invention.

In Fig. 1, the ink jet recording head 16 of the side shooter type is composed, for example, of the main body section 18 consisting of the ink supply section 18B, to which the ink tank IT is mounted, and the input terminal section 18A electrically connected to the carriage portion not illustrated and receiving the drive control signal group from the carriage portion; support member 20 joined to a joined surface 18b of recess 18BG in the ink supply section 18B of the main body section 18; the recording element board 24 bonded to an upper surface as a second joint surface in the support member 20; and the printed wiring board 22 electrically connected to the recording element board 24 and supplying the drive control signal group from the input terminal section 18A thereto.

The main body section 18 is constructed in such a way that the input terminal section 18A and ink supply section 18B are integrally molded, for example, of a resin. As shown in Fig. 1 and Figs. 2A, 2B, the generally rectangular recess 18BG is provided in the upper surface opposite to the mounting portion of ink tank IT in the ink supply section 18B of the main body section 18. The bottom of the recess 18BG is the joined surface 18b to which the support member 20 is bonded. Parts of the joined surface 18b are formed by the surface of block piece 26 made, for example, of an aluminum alloy. The block piece 26 is placed in the mold and is surrounded by a resin upon molding of the main body section 18. An elongate opening end of the ink supply passage 18a for introducing the ink from the ink tank IT is open at the nearly central portion of the joined surface 18b.

The recording element board 24 is constructed in the same structure as the recording element board 6 shown in Fig. 26B, and, therefore, detailed description of the internal structure thereof is omitted herein.

The substrate in the recording element board 24 is made of, for example, the silicon material of the thickness of 0.5 to 1.0 mm. Provided in the surface of the substrate to be bonded to the joined surface 18b of the recess 18BG of the ink supply section 18B with an adhesive is the ink supply opening portion 24c extending in the array direction of ink ejection outlets 24a and opposite to the orifice plate, as shown in Fig. 2A. Further, heaters not illustrated are arranged at predetermined mutual intervals on either side of the ink supply opening portion 24c in the substrate. One ends of the ink branching supply passages in the partition member are in communication with the ink supply opening portion 24c and each ink branching supply passage guides the ink supplied through the ink supply opening portion 24c to the associated heater.

The printed wiring board 22 is electrically connected to each electrode of the substrate in the recording element board 24, as shown in Fig. 1 and Figs. 2A and 2B. The printed wiring board 22 has the recording element board receiving section 24B, in which the recording element board 24 is placed, and the terminal section 24A disposed in the input terminal section 18A in the main body section 18. In bonding the printed wiring board 22 to the recording element board 24, they are connected, for example, by the TAB (Tape Automated Bonding) method.

The support member 20, which is placed between the recording element board 24 and the joined surface 18b of the recess 18BG of the ink supply section 18B, is formed in the rectangular plate shape, as shown in Fig. 1 and Figs. 2A and 2B. The support member 20 is made, for example, of silicon, which is the same material as the recording element board 24. The material for the support member 20 is not limited to silicon, but the support member 20 may be made of any material having the coefficient of linear expansion equal to that of the material for the recording element board 24 and having the thermal conductivity equal to or higher than that of the material for the recording element board 24. The material for the support member 20 may be, for example, either one of alumina (Al_2O_3), aluminum nitride (AlN), silicon carbide (SiC), trisilicon tetranitride (Si_3N_4), molybdenum (Mo), and tungsten (W).

The support member 20 has, as shown in Fig. 2A, the second joint surface 20sa, which is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24, and the first joint surface 20sb, which is bonded to the joined surface 18b of the recess 18BG of the ink supply section 18B. The support member 20 is provided with a communicating passage 20a extending long in the longitudinal direction at the position corresponding to the ink supply opening portion 24c in the recording element board 24 and to the ink supply passage 18a formed in the joined surface 18b of the recess 18BG of the ink supply section 18B. Further, lengths of the shorter sides and longer sides of the support member 20 are equal to those of the shorter sides and longer sides, respectively, of the recording element board 24, and the thickness of the support member 20 is almost equal to that of the recording ele-

ment board 24.

For placing th recording element board 24, to which the printed wiring board 22 is connected, the first joint surface 20sb of the support member 20 is first bonded to the predetermined position of the joined surface 18b with an adhesive. Subsequently, as shown in Fig. 2B, the second joint surface 20sa of the support member 20 is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24 with the adhesive. Examples of the adhesive preferably applicable are those having low viscosity, forming a thin adhesive layer on the contact surface, and having relatively high hardness after cured.

The number of communicating passage 20a in the support member 20 does not have to be limited to one as in the above example. The communication passage may be split into plural paths as shown in Fig. 3A and Fig. 3B. Fig. 3A and Fig. 3B each show support members 28 and 30 as other examples of the support member 20. The support members 28 and 30 are made of the same material as the support member 20 and the support member 28 is made in such a shape that slit-shaped communicating passages 28a and 28b extending in the longitudinal direction are located on a same straight line. In the support member 30, slit-shaped communicating passages 30a, 30b, and 30c extending in the longitudinal direction are positioned on a same straight line. Fig. 3C shows support member 32 as still another example of the support member 20. The support member 32 is also made of the same material as the support member 20 described above. The support member 32 has a circular through hole 32a at the almost center position. With the above arrangements, since in the support members 28 and 30 the portions except for the communicating passage are linked at one position in the almost central portion or at two positions, the mechanical strength or rigidity is improved as compared with the mechanical strength or rigidity of the support member 20. In the support member 32, the mechanical strength thereof is improved more than that of the support members 20, 28, and 30.

In the structure described above, when the drive control signal is supplied to each heater of the substrate in the recording element board 24 through the printed wiring board 22 to heat each heater, the ink is introduced through the ink supply passage 18a and through the ink branching supply passage of the partition member. The ink is heated by each heater to generate a bubble, based on the film boiling phenomenon, and with expansion of the bubble the ink is ejected from the ink ejection outlet 24a toward the recording surface of recording medium. On that occasion, even if the recording element board 24 expands because of the heat of the heaters, the support member 20 will also expand together with the recording element board 24. This means that the substantial cross-sectional area of the recording element board 24 is increased, which prevents the recording element board 24 from being broken by the change in temperature.

(Embodiment 2)

Fig. 4 schematically shows the major part of the second embodiment of the ink jet recording head according to the present invention.

In the example shown in Fig. 1 the lengths of the shorter sides and the longer sides of the support member 20 were equal to those of the shorter sides and the longer sides, respectively, of the recording element board 24 and the thickness of the support member 20 was generally equal to that of the recording element board 24; whereas in the example of Fig. 4 the length of the shorter sides of the support member 34 is longer than that of the shorter sides of the recording element board 24 and is set to a length generally equal to the width of the joined surface 18b of the recess 18BG of the ink supply section 18B.

In Fig. 4, the same reference symbols denote the same components as those in the example shown in Fig. 1 and redundant description thereof is omitted herein.

The support member 34 is formed in a rectangular plate shape. The support member 34 is made, for example, of silicon, which is the same material as the recording element board 24. The material for the support member 34 is not limited to silicon, but the support member 34 may be made of any material having the coefficient of linear expansion equal to that of the material for the recording element board 24 and having the thermal conductivity equal to or higher than that of the material for the recording element board 24. The material for the support member 34 may be, for example, either one of alumina (Al_2O_3), aluminum nitride (AlN), silicon carbide (SiC), trisilicon tetranitride (Si_3N_4), molybdenum (Mo), and tungsten (W).

The support member 34 has, as shown in Figs. 5A and 5B, the second joint surface 34sa, which is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24, and the first joint surface 34sb, which is bonded to the joined surface 18b of the recess 18BG of the ink supply section 18B. The support member 34 is provided with the communicating passage 34a extending long in the longitudinal direction at the position corresponding to the ink supply opening portion 24c in the recording element board 24 and to the ink supply passage 18a formed in the joined surface 18b of the recess 18BG of the ink supply section 18B. The communicating passage 34a may be formed in a split shape of plural passages, as shown in Figs. 3A to 3C.

In the structure described above, when the drive control signal is supplied to each heater of the substrate in the recording element board 24 through the printed wiring board 22 to heat each heater, the ink is introduced through the ink supply passage 18a and through the ink branching supply passage of the partition mem-

ber. The ink is heated by each heater to generate a bubble, based on the film boiling phenomenon, and with expansion of the bubble the ink is ejected from the ink ejection outlet 24a toward the recording surface of recording medium.

On that occasion, even if the recording element board 24 expands because of the heat of the heaters, the support member 34 will also expand together with the recording element board 24, as in the above example. This means that the substantial cross-sectional area of the recording element board 24 is increased, which prevents the recording element board 24 from being broken by the change in temperature. In addition, the mechanical strength and rigidity are increased further, because the shorter sides of the support member 34 are longer than those of the support member 20 in the example shown in Fig. 1.

(Embodiment 3)

Fig. 6A and Fig. 6B schematically show the major part of the third embodiment of the ink jet recording head according to the present invention.

In the example shown in Fig. 1 the lengths of the shorter sides and the longer sides of the support member 20 were equal to those of the shorter sides and the longer sides, respectively, of the recording element board 24 and the thickness of the support member 20 was generally equal to the thickness of the recording element board 24; whereas in the example of Figs. 6A and 6B the length of the shorter sides of the support member 36 is longer than that of the shorter sides of the recording element board 24 and the thickness of the support member 36 is greater than that of the recording element board 24. In Figs. 6A and 6B, the same reference symbols denote the same components as those in the example shown in Fig. 1 and redundant description thereof is omitted herein.

The support member 36 is formed in a rectangular plate shape. The support member 36 is made, for example, of silicon, which is the same material as the recording element board 24. The material for the support member 36 is not limited to silicon, but the support member 36 may be made of any material having the coefficient of linear expansion equal to that of the material for the recording element board 24 and having the thermal conductivity equal to or higher than that of the material for the recording element board 24. The material for the support member 36 may be, for example, either one of alumina (Al_2O_3), aluminum nitride (AlN), silicon carbide (SiC), trisilicon tetranitride (Si_3N_4), molybdenum (Mo), and tungsten (W).

The support member 36 has, as shown in Figs. 6A and 6B, the second joint surface 36sa, which is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24, and the first joint surface 36sb, which is bonded to the joined surface 18b of the recess 18BG of the ink supply section 18B. The support member 36 is provided with the communicating passage 36a extending long in the longitudinal direction at the position corresponding to the ink supply opening portion 24c in the recording element board 24 and to the ink supply passage 18a formed in the joined surface 18b of the recess 18BG of the ink supply section 18B. The communicating passage 36a may be formed in a split shape of plural passages, as shown in Figs. 3A to 3C.

In the structure described above, when the drive control signal is supplied to each heater of the substrate in the recording element board 24 through the printed wiring board 22 to heat each heater, the ink is introduced through the ink supply passage 18a and through the ink branching supply passage of the partition member. The ink is heated by each heater to generate a bubble, based on the film boiling phenomenon, and with expansion of the bubble the ink is ejected from the ink ejection outlet 24a toward the recording surface of recording medium. On that occasion, even if the recording element board 24 expands because of the heat of the heaters, the support member 36 will also expand together with the recording element board 24, as in the above example. This means that the substantial cross-sectional area of the recording element board 24 is increased, which prevents the recording element board 24 from being broken by the change in temperature. In addition, the mechanical strength and rigidity are increased much more, because the shorter sides and the thickness of the support member 36 are longer or thicker, respectively, than those of the support member 20 in the example shown in Fig. 1.

(Embodiment 4)

Fig. 7 schematically shows the major part of the fourth embodiment of the ink jet recording head according to the present invention.

In the example shown in Fig. 4 the length of the shorter sides of the support member 34 to which the recording element board 24 was bonded was longer than that of the shorter sides of the recording element board 24 and generally equal to the width of the joined surface 18b of the recess 18BG of the ink supply section 18B, and the printed wiring board 22 connected to the recording element board 24 was bonded to the periphery around the recess 18BG of the ink supply section 18B; in the example of Fig. 7, in addition to the foregoing, frame member 38 is provided as a second support member and the printed wiring board 22 connected to the recording element board 24 is placed in the periphery around the recess 18BG of the ink supply section 18B through the frame member 38.

In Fig. 7 the same reference symbols denote the same components as those in the example shown in Fig. 4, and redundant description thereof is omitted herein.

In the example shown in Fig. 7, the main body sec-

tion 42 is composed of the ink supply section 42B, to which the ink tank IT is mounted, and the input terminal section 42A electrically connected to the carriage portion not illustrated and receiving the drive control signal group from the carriage portion.

The main body section 42 is made in such a manner that the input terminal section 42A and ink supply section 42B are integrally molded, for example, of a resin. As shown in Fig. 7 and Figs. 8A and 8B, the generally rectangular recess 42BG is formed in the upper surface opposite to the portion to which the ink tank IT is mounted in the ink supply section 42B of the main body section 42. The bottom of the recess 42BG is the joined surface 42b to which the support member 40 as the first support member is bonded. A flat surface in the periphery around the recess 42BG is a joined surface 42c to which the frame member 38 as the second support member is bonded.

An elongate opening end of the ink supply passage 42a for introducing the ink from the ink tank IT is open in the almost central portion of the joined surface 42b.

The support member 40 is formed in a rectangular plate shape having the thickness generally equal to that of the recording element board 24. The support member 40 is made, for example, of silicon, which is the same material as the recording element board 24. The material for the support member 40 is not limited to silicon, but the support member 40 may be made of any material having the coefficient of linear expansion equal to that of the material for the recording element board 24 and having the thermal conductivity equal to or higher than that of the material for the recording element board 24. The material for the support member 40 may be, for example, either one of alumina (Al_2O_3), aluminum nitride (AlN), silicon carbide (SiC), trisilicon tetranitride (Si_3N_4), molybdenum (Mo), and tungsten (W).

As shown in Figs. 8A and 8B, the support member 40 has the thickness generally equal to the depth of the recess 42BG of the ink supply section 42B and has the width and length generally equal to those of the recess 42BG. The support member 40 has the second joint surface 40sa bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24 and to one joint surface of the frame member 38, and the first joint surface 40sb bonded to the joined surface 42b of the recess 42BG of the ink supply section 42B. The support member 40 is provided with the communicating passage 40a extending long in the longitudinal direction, at the position corresponding to the ink supply opening portion 24c in the recording element board 24 and to the ink supply passage 42a provided in the joined surface 42b of the recess 42BG of the ink supply section 42B. The communicating passage 40a may be formed in a split shape of plural passages, as shown in Figs. 3A to 3C.

The frame member 38 is made, for example, of an aluminum alloy in a plate shape of a predetermined thickness and receives th heat generated in the recording element board through the support member, thereby easily radiating the heat. The material for the frame member 38 is not limited to the aluminum alloy, but the material may be selected, as desired, from materials having relatively large thermal conductivities. The frame member 38 has the thickness nearly equal to the thickness of the recording element board 24 and is formed in the width and length nearly equal to those of the joined surface 42c of the ink supply section 42B. Provided in the central portion of the frame member 38 is opening portion 38a to surround the recording element board 24 bonded. Owing to this arrangement, the printed wiring board connected to the recording element board is supported by the frame member having the height generally equal to that of the recording element board, which enhances the reliability of the electric connection part of the printed wiring board.

For placing the recording element board 24, to which the printed wiring board 22 is connected, in the ink supply section 42B, as shown in Fig. 8A, the first joint surface 40sb of the support member 40 is first placed opposite to the joined surface 42b and thereafter is bonded to the predetermined position of the joined surface 42b with an adhesive. This adhesive is preferably, for example, one having high viscosity and having relatively low hardness after cured to show elasticity.

Subsequently, as shown in Fig. 8B, the frame member 38 is positioned at the predetermined position on the joined surface 42c in the ink supply section 42B and on the second joint surface 40sa of the support member 40 and is bonded in close fit thereto without clearance with an adhesive. This adhesive is preferably, for example, one having a relatively high thermal conductivity after cured.

Then, as shown in Fig. 8B, the second joint surface 40sa of the support member 40 is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24 with an adhesive. The adhesive is preferably, for example, one having low viscosity, forming a thin adhesive layer on the contact surface, and having relatively high hardness after cured. On that occasion, the clearance between the printed wiring board 22 and the recording element board 24 connected therewith is desirably sealed with an adhesive having elasticity after cured.

By this, the recording element board 24 to which the printed wiring board 22 is connected is placed in the ink supply section 42B.

In the structure described above, when the drive control signal is supplied to each heater of the substrate in the recording element board 24 through the printed wiring board 22 to heat each heater, the ink is introduced through the ink supply passage 18a and through the ink branching supply passage of the partition member. The ink is heated by each heater to generate a bubble, based on the film boiling phenomenon, and with expansion of the bubble the ink is ejected from the ink

ejection outlet 24a toward the recording surface of recording medium. On that occasion, even if th recording element board 24 expands becaus of the heat of the heaters, the support member 40 will also expand together with the recording element board 24. This means that the substantial cross-sectional area of the recording element board 24 is increased, which prevents the recording element board 24 from being broken by the change in temperature.

Since the second joint surface 40sa of the support member 40 is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24 with the adhesive having the relatively high hardness after cured, the mechanical strength and rigidity of the recording element board 24 are enhanced further. Since the first joint surface 40sb of the support member 40 is bonded at the predetermined position of the joined surface 42b with the adhesive having the relatively low hardness after cured to show elasticity, the recording element board 24 is prevented from being deformed by thermal stress due to the difference between the coefficient of linear expansion of the support member 40 and the coefficient of linear expansion of the ink supply section 42B. Further, the frame member 38 radiates the heat from the recording element board 24 through the support member 40.

Figs. 9A and 9B show another example of the frame member 38 in the example shown in Fig. 7. The same reference symbols denote the same components as those in the example shown in Fig. 7, and redundant description thereof is omitted herein.

In Figs. 9A and 9B, the frame member 44 is made, for example, of an aluminum alloy, as in the example shown in Fig. 7, in a plate shape of a predetermined thickness by press working. The frame member 44 has the uniform thickness generally equal to that of the recording element board 24 and is formed in the width and length generally equal to those of the joined surface 42c of the ink supply section 42B. The frame member 44 has bent portions 44a at the both edges. Further, the frame member 44 has the opening portion 44b to surround the recording element board 24 bonded.

On the other hand, the ink supply section 42B is provided with elongate slots 46, with which the bent portions 44a of the frame member 44 are engaged, along the longitudinal direction of the recess 42BG.

For placing the recording element board 24, to which the printed wiring board 22 is connected, in the ink supply section 42B in use of the above-stated frame member 44, as shown in Fig. 9A, the first joint surface 40sb of the support member 40 is first placed opposite to the joined surface 42b and thereafter is bonded to the predetermined position of the joined surface 42b with an adhesive. This adhesive is preferably, for example, one having high viscosity and having relatively low hardness after cured to show elasticity.

Subsequently, as shown in Fig. 9B, the bent portions 44a of the frame member 44 are engaged with the respective slots 46 with predetermined clearance, whil the frame member 44 is positioned at the predetermined position on the joined surface 42c in the ink supply section 42B and on the second joint surface 40sa of the support member 40 and is bonded in close fit thereto without clearance with an adhesive. This adhesive is preferably, for example, one having a relatively high thermal conductivity after cured.

Then, as shown in Fig. 9B, the surface provided with the ink supply opening portion 24c in the recording element board 24 is bonded to the second joint surface 40sa of the support member 40 with an adhesive. The adhesive is preferably, for example, one having low viscosity, forming a thin adhesive layer on the contact surface, and having relatively high hardness after cured. Hence, the heat radiation area of the frame member 44 becomes greater than that of the above-stated frame member 38, which improves the cooling effect by heat radiation of frame member 44.

Figs. 10A and 10B show still other examples of the frame member 38. The frame member 44 described above was made of the plate of uniform thickness, but the frame member 48 shown in Fig. 10A has bent portions 48a at the both edges thereof. Provided in the central portion of the frame member 48 is the opening portion 48b in which the recording element board 24 bonded is placed. Since the bent portions 48a are formed by folding the edges back by hemming work, the thickness thereof is larger than that of the other portion. This increases the heat radiation area in the frame member 48 as compared with the frame member 44.

The frame member 50 shown in Fig. 10B is molded by extrusion molding. The frame member 50 has the bent portions 50a at the both edges thereof. Provided in the central portion of the frame member 50 is the opening portion 50b in which the recording element board 24 bonded is placed. The bent portions 50a are molded thicker than the other portion. This increases the heat radiation area in the frame member 50 as compared with the frame member 44, as in the above example.

(Embodiment 5)

Fig. 11 schematically shows the major part of the fifth embodiment of the ink jet recording head according to the present invention.

In the example shown in Fig. 7 the frame member 38 was provided as the second support member and the printed Wiring board 22 connected to the recording element board 24 was placed on the periphery around the recess 42BG of the ink supply section 42B through the frame member 38; whereas in the example of Fig. 11, in addition to the foregoing, a groove 54 for holding the adhesive applied is provided in the bottom portion of the recess 52BG of the ink supply section 52B.

In Fig. 11, the same reference symbols denote the same components as those in the example shown in Fig. 7, and redundant description thereof is omitted

herein.

In the example shown in Fig. 11, th main body section 52 is composed of the ink supply section 52B, to which the ink tank IT is mounted, and the input terminal section 52A electrically connected to the carriage portion not illustrated and receiving the drive control signal group from the carriage portion.

The main body section 52 is made in such a manner that the input terminal section 52A and ink supply section 52B are integrally molded, for example, of a resin. As shown in Fig. 11 and Figs. 12A and 12B, the nearly rectangular recess 52BG is formed in the upper surface opposite to the portion to which the ink tank IT is mounted, in the ink supply section 52B of the main body section 52. The bottom of the recess 52BG serves as joined surface 52b to which the support member 40 as a first support member is bonded. A flat surface in the periphery around the recess 52BG serves as joined surface 52c to which the frame member 38 as a second support member is bonded.

An elongate opening end of the ink supply passage 52a for introducing the ink from the ink tank IT is open at the almost central portion of the joined surface 52b. In the peripheral region around the elongate opening end of the ink supply passage 52a in the joined surface 52b, the groove 54, the cross-sectional shape of which is, for example, a V-shape, is provided so as to surround the opening end. Without having to be limited to the V-shape, the cross-sectional shape of the groove 54 may be a U-shape or a cornered U-shape.

For placing the recording element board 24, to which the printed wiring board 22 is connected, in the ink supply section 52B in use of the frame member 38, as shown in Fig. 12A, the first joint surface 40sb of the support member 40 is first placed opposite to the joined surface 52b and thereafter is bonded to the predetermined position of the joined surface 52b with an adhesive applied. This adhesive is preferably, for example, one having high viscosity and having relatively low hardness after cured to show elasticity. On that occasion, the adhesive Pa applied is held in the groove 54, as shown in Fig. 12B. By this, the adhesive layer is obtained in a predetermined thickness according to the depth of the groove 54, so that undesired leakage of ink is avoided and so that the flatness of the support member 40 relative to the joined surface 52b is assured with accuracy.

Subsequently, as shown in Fig. 12B, the frame member 38 is positioned at the predetermined position on the joined surface 52c in the ink supply section 52B and on the second joint surface 40sa of the support member 40 and then is bonded in close fit thereto without clearance with an adhesive. This adhesive is preferably, for example, one having a relatively high thermal conductivity after cured.

Then, as shown in Fig. 12B, the second joint surface 40sa of the support member 40 is bonded to the surface provided with the ink supply opening portion 24c in the recording element board 24 with an adhesive. The adhesive is preferably, for example, one having low viscosity, forming a thin adhesive layer on the contact surface, and having relatively high hardness after cured. On that occasion, the clearance between the printed wiring board 22 and the recording element board 24 connected is preferably sealed with an adhesive having elasticity after cured.

By this, the recording element board 24 to which the printed wiring board 22 is connected is placed in the ink supply section 52B.

(Embodiment 6)

Fig. 13 and Fig. 14 schematically show the major part of the sixth embodiment of the ink jet recording head according to the present invention.

In Fig. 13 and Fig. 14, the ink jet recording head 60 of the side shooter type is comprised, for example, of the main body section 72 consisting of the ink supply section 72B, to which ink tanks INT1, INT2, and INT3 are mounted, and the input terminal section 72A electrically connected to the carriage portion not illustrated and receiving the drive control signal group from the carriage portion; and the ink ejection section 79 provided at the portion opposite to the ink supply section 72B in the main body section 72 and having ink ejection outlets for selectively ejecting the ink from the ink supply section 72B.

In the ink supply section 72B, ink tank receiving sections 78A, 78B, and 78C in which the ink tanks INT1, INT2, and INT3 are mounted are arrayed along the scanning direction of the ink jet recording head 60 extending along the coordinate axis X shown in Fig. 14. A pair of contact portions 76ay and 76by for positioning relative to mount portion 80a of the carriage portion 80 on which the ink jet recording head 60 is mounted are provided at the edges in the direction of the coordinate axis Y shown in Fig. 14 in the outer shell forming the ink tank receiving sections 78A, 78B, and 78C. The contact portions 76ay and 76by are disposed opposite to and in parallel to each other and position the ink jet recording head 60 in the direction of the coordinate axis Y shown in Fig. 14 with respect to the mount portion 80a in the carriage portion 80, as shown in Fig. 15.

Another contact portion 76az is provided between the contact portion 76ay and the contact portion 76by. As shown in Fig. 15, the contact portion 76az positions the ink jet recording head 60 in the direction of the coordinate axis Z shown in Fig. 14 with respect to the mount portion 80a in the carriage portion 80.

In addition, contact portions 76bz and 76cz disposed opposite to each other are provided on the both side wall portions in the direction along the coordinate axis X in the outer shell for forming the ink tank receiving sections 78A, 78B, and 78C, as shown in Fig. 13 and Fig. 14. The contact portions 76bz and 76cz position the ink jet recording head 60 in the direction of the coordinate axis Z shown in Fig. 14 with respect to the

mount portion 80a in the carriage portion 80, as shown in Fig. 15.

Further, a contact portion 76ax is provided below the contact portion 76bz on the side wall portion where the contact portion 76bz is provided. The contact portion 76ax positions the ink jet recording head 60 in the direction of the coordinate axis X shown in Fig. 14 with respect to the mount portion 80a in the carriage portion 80, as shown in Fig. 16.

By this, at the mount portion 80a in the carriage portion 80 the ink jet recording head 60 is positioned at one position in the direction of the coordinate axis X shown in Fig. 14, for example, by making urging force of a plate spring acting on the contact portion 76ax along the direction indicated by the arrow Px of Fig. 16. In addition, the ink jet recording head 60 is positioned at two positions in the direction of the coordinate axis Y shown in Fig. 14, for example, by making pressing force of contact pads (rubber pads) acting on the contact portions 76ay and 76by along the direction indicated by the arrow Py. Further, the ink jet recording head 60 is positioned at the three positions in the direction of the coordinate axis Z shown in Fig. 14, for example, by making urging force of a coil spring acting on the contact portions 76az, 76bz, and 76cz along the direction indicated by the arrow Pz.

Accordingly, the ink jet recording head 60 is properly positioned relative to the mount portion 80a in the carriage portion 80 automatically and securely when the ink jet recording head 60 is mounted on the mount portion 80a.

The joined surface 72S is formed on the ink ejection section 79 side in the main body section 72, as shown in Fig. 13. As shown in Fig. 13 and Fig. 17, one opening ends 82a, 82b, and 82c of the ink supply passages 82A, 82B, 82C in communication with the ink tank receiving portions 78A, 78B, and 78C, respectively, are open in the joined surface 72S. The ink ejection section 79 is disposed on the joined surface 72S, as shown in Fig. 13.

The ink ejection section 79 is composed of support member 70 joined to the joined surface 72S, a plurality of recording element boards 62, 64, and 66 bonded to the upper surface as a second joint surface in the support member 70, printed wiring boards 62P, 64P, and 66P electrically connected to the recording element boards 62, 64, and 66, respectively, and supplying the drive control signal group from the input terminal section 72A thereto, and frame member 68 for positioning the printed wiring boards 62P, 64P, and 66P together with the plurality of recording element boards 62, 64, and 66, the frame member 86 being disposed on the upper surface of the support member 70.

The support member 70 as a first support member is formed in a rectangular plate shape in the thickness generally equal to that of the recording element boards 62 to 66. The width W of the support member 70 along the array direction of the recording element boards 62 to 66, described below, is set to be equal to or longer than the length L from one edg of the recording element board 62 to the other edge of the recording element board 66, as shown in Fig. 19. The support member 70 is made, for example, of silicon, which is the same material as the recording element boards 62 to 66. The material for the support member 70 is not limited to silicon, but the support member 70 may be made of any material having a coefficient of linear expansion equal to that of the material for the recording element boards 62 to 66 and having a thermal conductivity equal to or higher than that of the material for the recording element boards 62 to 66. The material for the support member 40 may be, for example, either one of alumina (Al_2O_3), aluminum nitride (AlN), silicon carbide (SiC), trisilicon tetranitride (Si_3N_4), molybdenum (Mo), and tungsten (W).

The support member 70 has through holes 70a, 70b, and 70c on a same straight line. The support member 70 has the first joint surface 70sa facing the frame member 68 and the second joint surface 70sb facing the joined surface 72S of the main body section 72. The second joint surface 70sb in the support member 70 is bonded to the joined surface 72S with an adhesive.

On that occasion, as shown in Fig. 13 and Fig. 17, the through hole 70a is in communication with the opening end 82a of the ink supply passage 82A through the ink flow path 86A provided in the joined surface 72S. The through hole 70b is in communication with the opening end 82c of the ink supply passage 82C through ink flow path 86C provided in the joined surface 72S. The through hole 70c is in communication with the opening end 82b of the ink supply passage 82B through ink flow path 86B provided with curvature on the ink flow passage 86A side in the joined surface 72S.

In this arrangement, the ink supplied through the ink supply passage 82C is supplied through the ink flow path 86C to the through hole 70b of the support member 70 and then is supplied to the recording element board 64. The ink supplied through the ink supply passage 82B is supplied through the ink flow path 86B to the through hole 70c of the support member 70 and then is supplied to the recording element board 62. Further, the ink supplied through the ink supply passage 82A is supplied through the ink flow path 86A to the through hole 70a of the support member 70 and then is supplied to the recording element board 66.

Now, let us consider an example in which the recording element boards 62 and 66 are desired to eject ink of a same color and in which the recording element board 64 is desired to eject ink of a different ink color. As shown in Fig. 18, ink of an arbitrary color is reserved in the ink tank INT3 and ink of the same color is reserved in the ink tanks INT1 and INT2. When the respective ink liquids are supplied, the ink reserved in the ink tank INT3 is supplied through the through hole 70b of the support member 70 to the recording element board 64 and the ink liquids reserved in the ink tanks INT1 and

INT2 are supplied to the recording element boards 62 and 66, respectively. Thus, this facilitates arrangement of the ink tanks INT1 and INT2. In the case wherein the ink tanks INT1 and INT2 are replaced by one ink tank, the ink can also be supplied to each of the recording element boards 62 and 66.

Since the recording element boards 62, 64, and 66 have the same structure, description is given as to only the recording element board 62.

The substrate 62k of the recording element board 62 is made of, for example, a silicon material of the thickness of 0.5 to 1.0 mm. Provided in the surface of the substrate 62k, which is bonded to the first joint surface 70sa of the support member 70 with an adhesive, is ink supply opening portion 62ka extending in the array direction of the ink ejection outlets 62Fa opposite to the orifice plate 62F, as shown in Fig. 19. Further, heaters not illustrated are arranged at predetermined mutual intervals on either side of the ink supply opening portion 62ka in the orifice plate 62F. The ink supplied through the ink supply opening portion 62ka is guided through the flow paths formed in the orifice plate 62F to the associated heaters.

The printed wiring board 62P is electrically connected to each electrode of the substrate in the recording element board 62, as shown in Fig. 13 and Fig. 17. In bonding the printed wiring board 62P to the recording element board 62, they are connected to each other, for example, by the TAB (Tape Automated Bonding) method.

In the frame member 68 as a second support member, opening portions 68a, 68b, 68c for regulating the positions of the recording element boards 62, 64, 66 are provided in parallel and in correspondence to the recording element boards 62, 64, 66.

For placing the recording element board 62 coupled with the printed wiring board 62P, the recording element board 64 coupled with the printed wiring board 64P, and the recording element board 66 coupled with the printed wiring board 66P on the joined surface 72S of the main body section 72 through the frame member 68 and support member 70, as shown in Fig. 19 and Fig. 20, the second joint surface 70sb of the support member 70 is first bonded to the joined surface 72S with an adhesive. Then the frame member 68 is bonded to the first joint surface 70sa of the support member 70 in correspondence to the through holes 70a, 70b, and 70c. Then the recording element board 62 coupled with the printed wiring board 62P, the recording element board 64 coupled with the printed wiring board 64P, and the recording element board 66 coupled with the printed wiring board 66P are inserted into the respective opening portions 68a to 68c to be bonded to the first joint surface 70sa of the support member 70 with an adhesive. On that occasion, the recording element boards are positioned, for example, by use of the picture recognition technology so that the ink ejection outlets of each orifice plate 62F ro 66F are directed in the same direction.

By this, the plural recording element boards 62, 64, and 66 are assembled as being bonded to one support member 70, which enhances th assembling accuracy and which in turn enhances the recording accuracy. Since the support member 70 is made of the material as described, thermal deformation of the recording element boards 62, 64, and 66 due to thermal expansion thereof is avoided.

Fig. 21 shows an example in which flatness is not good of the first joint surface 70sa' and the second joint surface 70sb' in the support member 70' with respect to the joined surface 72S. In this case, when the recording element boards 62, 64, and 66 are bonded to the support member 70', the ink ejected from the recording element boards 62, 64, and 66 will be ejected in different ejection directions indicated by arrows Ia to Ic in Fig. 21.

Therefore, the flatness of the first joint surface in the support member 70 is maintained at high accuracy and the adhesive layer is made thin. Alternatively, the adhesive with relatively low viscosity is selected and predetermined pressure is applied to the adhesive, which can avoid the accident shown in Fig. 21.

In an example shown in Fig. 22, the width W of the support member 90 along the array direction of the recording element boards 62 to 66 is a little larger than length K between the through hole 90a and through hole 90c. The same reference symbols denote the same components as those in the example shown in Fig. 19, and redundant description thereof is omitted herein.

By this arrangement, since the support member 90 is a member purposed mainly to assure the positioning accuracy of the plural recording element boards, a requirement is simply that at least one end of the support member 90 is defined in such a size as to contact an inner surface of peripheral wall 72G in the joined surface 72S. On the other hand, in an example wherein the both ends of the support member 90' do not contact the inner surface of the peripheral wall 72G in the joined surface 72S as shown in Fig. 23, the ink supply opening portions 62ka to 66ka of the respective recording element boards 62 to 66 could be deformed by the heat of heater.

Fig. 24 shows an example in which the first joint surface 92sa out of the first joint surface 92sa and the second joint surface 92sb in the support member 92 is provided with recesses 92GA, 92GB, and 92GC corresponding to the recording element boards 62 to 66.

In Fig. 24, the same reference symbols denote the same components as those in the example shown in Fig. 20, and redundant description thereof is omitted herein.

The recesses 92GA, 92GB, and 92GC are formed in a predetermined depth and at predetermined intervals. The recesses 92GA, 92GB, and 92GC are made by processing, for example, such as sand blasting or anisotropic etching.

By this arrangement, the outer periphery of the

recording element boards 62 to 66 can be positioned with better accuracy to the inner periphery of the recesses 92GA, 92GB, and 92GC.

As described above, since the ink jet recording heads according to the above embodiments are arranged so that the recording element board(s) is placed on the joined surface in the main body section with intervention of the support member(s) and so that the thermal property in the material for the recording element board(s) and that of the material for the support member(s) are of the same quality, as the recording element board thermally expands, the support member also thermally expands together with the recording element board. This increases the rigidity of recording element board, prevents the recording element board from being broken by the change in the temperature of recording element board, and avoids the increase in the manufacturing cost of recording element board.

(Embodiment 7)

In the form of the ink jet recording head of Embodiment 6, there exists the clearance between the recording element boards and the wiring boards; if the recording liquid should stay in this clearance, the recording liquid could permeate the wiring board and the support member to reach the back of wiring board and to corrode the wiring. This recording liquid could also corrode the frame member. The present embodiment is achieved for solving such problem.

Fig. 30 is an exploded, perspective view to show the seventh embodiment of the ink jet recording head according to the present invention and Figs. 31A and 31B are drawings to show the completely assembled state of the ink jet recording head shown in Fig. 30, wherein Fig. 31A is a perspective view of the appearance and Fig. 31B is a partially enlarged view of the cross section along 31B-31B shown in Fig. 31A.

As shown in Fig. 30 and Figs. 31A and 31B, the present embodiment is composed of a plurality of recording element boards 101a to 101c in each of which a plurality of ejection outlets 102 with the recording elements for ejecting the recording liquid are arrayed; wiring boards 104a to 104c, each having an opening portion in which the recording element board 101a to 101c is mounted, being connected to the recording element board 101a to 101c mounted in the opening portion by the TAB mounting method, and sending an electric signal for ejecting the recording liquid to the recording element board 101a to 101c; sealing resin 105 for protecting lead wires for connection between the recording element board 101a to 101c and the wiring board 104a to 104c from corrosion by the recording liquid and from disconnection due to force acting from the outside; support member 107 for holding and securing the recording element boards 101a to 101c; support plate 108 having opening portions for permitting the recording element boards 101a to 101c to contact the support member 107, the support plate 108 holding and securing the wiring boards 104a to 104c; adhesive resin 109 for adhering th wiring boards 104a to 104c to the support plate 108; and wiring integration board 110 for integration of electric signals to the wiring boards 104a to 104c. The opening portions of the wiring boards 104a to 104c and the opening portions of the support plate 108 are so sized as to be nearly equal to each other and slightly larger than the recording element boards 101a to 101c. The sealing resin 111 fills the clearance formed between the recording element board 101a to 101c and the wiring board 104a to 104c or the support plate 108, i.e., portions in each opening portion of the support plate 108 where the recording element board 101a to 101c does not occupy.

The assembling method of the ink jet recording head of the arrangement as described above will be described.

First, a heating resistor layer and wires are patterned on a silicon wafer by the photolithography technology and then nozzle walls and ejection outlets 102 are made of a photosensitive resin. Next, recording liquid supply ports are formed by anisotropic etching, sand blasting, or the like, and thereafter the contour is made by cutting, thus forming the recording element board 101a to 101c.

Next, the recording element boards 101a to 101c are electrically connected with the respective wiring boards 104a to 104c for receiving the electric signals by the TAB mounting technology, and the sealing resin 105 is applied onto the electric signal input terminals on the recording element board 101a to 101c side, used for connection, and onto the lead wires on the wiring board 104a to 104c side.

Then the recording element boards 101a to 101c are bonded to the support member 107, and the wiring boards 104a to 104c are bonded to the support plate 108 with the adhesive resin 109, whereby the recording element units 106a to 106c each comprised of the recording element board 101a to 101c and the wiring board 104a to 104c are fixed to the structural body of the ink jet recording head comprised of the support member 107 and support plate 108.

Then the wiring boards 104a to 104c are electrically connected with the wiring integration board 110 and the wiring integration board 110 is held and secured on the support member 107.

After that, the sealing resin 111 is charged into the clearance between the recording element board 101a to 101c and the wiring board 104a to 104c or the support plate 108.

An aluminum material is usually used for the support plate 108 in terms of the cost, processability, thermal conduction property, and so on.

Normally, as described above, the recording element boards 101a to 101c and the wiring boards 104a to 104c are electrically connected by the lead wires by use of the TAB mounting technology, the lead wires are

preliminarily protected by the sealing resin 105 in the form of the recording element units 106a to 106c for preventing corrosion by the recording liquid, disconnection by the force acting from the outside, and so on, and they are held and fixed on the support member 107 and the support plate 108.

Although there is another method for preventing remaining of the recording liquid by narrowing the gap to the wiring board 104a to 104c at the end face of the recording element board 101a to 101c on the side having no electric contact terminal with the wiring board 104a to 104c, the method for filling the clearance formed between the recording element board 101a to 101c and the support plate 108 with the sealing resin 111 can prevent the remaining of recording liquid more securely. In this case, the lower the viscosity of the sealing resin 111, the better the flow of the resin into fine portions, which makes the surface of sealing resin flatter. This is more advantageous for preventing the remaining of recording liquid. The sealing resin 111 may be a silicone resin or a urethane resin, and it is preferably a resin with repellency against the recording liquid.

In the present embodiment, as described above, the sealing resin 105, 111 fills the clearance formed between the recording element board 101a to 101c and the support plate 108 to eliminate the clearance between the recording element board 101a to 101c and the wiring board 104a to 104c and to prevent the recording liquid from remaining around the recording element boards 101a to 101c, thereby preventing corrosion of the wiring boards 104a to 104c and the support plate 108.

(Embodiment 8)

Fig. 32 is a drawing to show the eighth embodiment of the ink jet recording head according to the present invention.

In comparison with the seventh embodiment, the present embodiment is arranged so that the opening portions of the support plate 108 are larger than the opening portions of the wiring boards 104a to 104c as shown in Fig. 32.

In the present embodiment constructed as described above, the portion around the opening portion can certainly contact the sealing resin 111 on the back surface of the wiring board 104a to 104c, whereby the recording liquid can be prevented more securely from flowing to the back surface of the wiring board 104a to 104c. In the support plate 108, the recording liquid is also prevented from flowing to the back side and from contacting it.

(Embodiment 9)

Fig. 33A and Fig. 33B are drawings to show the completely assembled state of the ninth embodiment of the ink jet recording head according to the present invention, wherein Fig. 33A is a perspective view of the appearance and Fig. 33B is a partially enlarged view of the cross section along 33B-33B shown in Fig. 33A.

As shown in Figs. 33A and 33B, the present embodiment is achieved by modifying the arrangement of Embodiment 8 in such a manner that the sealing resin 111 is further provided on the surface of portions exposed to the outside without provision of recording element unit on the support plate 108.

Normally, on the support plate 108 there is a difference of height corresponding to the thicknesses of the wiring board 104a to 104c and the adhesive resin 109 between the surface of the wiring board 104a to 104c and the portions of the support plate 108 exposed to the outside, so that the portions of the support plate 108 exposed to the outside constitute grooves having the depth corresponding to that height. If the recording liquid should remain in such a groove, the recording liquid could flow to the back side of the wiring board 104a to 104c so as to corrode the wires or to corrode the surface of support plate 108, as described above in Embodiments 7 and 8.

By placing the sealing resin 111 on the support plate 108 exposed to the outside as in the present embodiment, the recording liquid is prevented from flowing to the back side of the wiring board 104a to 104c and thereby from corroding the wires and the surface of support plate 108.

A charge amount of the sealing resin 111 is determined desirably so as to be just enough to fill the level difference corresponding to the thicknesses of the wiring board 104a to 104c and the adhesive resin 109.

(Embodiment 10)

Fig. 34 is an exploded, perspective view to show the tenth embodiment of the ink jet recording head according to the present invention and Figs. 35A and 35B are drawings to show the completely assembled state of the ink jet recording head shown in Fig. 34, wherein Fig. 35A is a perspective view of the appearance and Fig. 35B is a partially enlarged view of the cross section along 35B-35B shown in Fig. 35A.

As shown in Fig. 34 and Figs. 35A and 35B, the present embodiment is composed of a plurality of recording element boards 101a to 101c in each of which a plurality of ejection outlets 102 with the recording elements for ejecting the recording liquid are arrayed; wiring boards 104a to 104c connected with the respective recording element boards 101a to 101c by the TAB mounting method and sending the electric signal for ejecting the recording liquid to each of the recording element boards 101a to 101c; sealing resin 105 for protecting the lead wires for connecting the recording element board 101a to 101c with the wiring board 104a to 104c from corrosion by the recording liquid and from disconnection due to the force acting from the outside; support member 107 for holding and securing the recording ele-

ment boards 101a to 101c; support plate 108 for holding and securing the wiring boards 104a to 104c; adhesive resin 109 for adhering the wiring boards 104a to 104c to the support plate 108; and wiring integration board 110 for integration of electric signals to the wiring boards 104a to 104c; and grooves 112 are provided from the support plate 108 to the wiring integration board 110 on the both outer sides of a portion of the support member 107 corresponding to each bent portion of the wiring board 104a to 104c.

The assembling method of the ink jet recording head of the arrangement as described above will be described.

First, the heating resistor layer and wires are patterned on a silicon wafer by the photolithography technology and then the nozzle walls and ejection outlets 102 are made of a photosensitive resin. Next, the recording liquid supply ports are formed by anisotropic etching, sand blasting, or the like, and thereafter the contour is made by cutting, thus forming the recording element board 101a to 101c.

Next, the recording element boards 101a to 101c are electrically connected with the respective wiring boards 104a to 104c for receiving the electric signals by the TAB mounting technology, and the sealing resin 105 is applied onto the electric signal input terminals on the recording element board 101a to 101c side, used for connection, and onto the lead wires on the wiring board 104a to 104c side.

Then the recording element boards 101a to 101c are bonded to the support member 107, and the wiring boards 104a to 104c are bonded to the support plate 108 with the adhesive resin 109, whereby the recording element units 106a to 106c each comprised of the recording element board 101a to 101c and the wiring board 104a to 104c are fixed to the structural body of the ink jet recording head comprised of the support member 107 and support plate 108.

After that, the wiring boards 104a to 104c are electrically connected with the wiring integration board 110 and the wiring integration board 110 is held and secured on the support member 107.

An aluminum material is usually used for the support plate 108 in terms of the cost, processability, thermal conduction property, and so on.

As described above, the wiring boards 104a to 104c are arranged so that the bonded surface thereof to the support plate 108 is bonded to the support plate 108 by the adhesive resin 109 and the electric signal input terminal side thereof is electrically connected with the wiring integration board 110 and is fixed. Since the recording element boards 101a to 101c in the recording element units 106a to 106c and the wiring integration board 110 are bonded and fixed to the support member 107 with high position accuracy, it is very difficult to bond and fix the bent portions of the wiring boards 104a to 104c to the support member 107 by heat seal or the like. It is thus normal to seal the periphery of the wiring board 104a to 104c with the sealing resin 111 for the purpose of preventing th recording liquid from flowing to the back side of the wiring board 104a to 104c and for adhesion of the wiring board 104a to 104c to the support member 107. However, since the clearance is very narrow between the bent portion of wiring board 104a to 104c and the support member 107, the sealing resin 111 permeates into the clearance by capillarity and it is thus difficult to stabilize amounts of sealing resin 111 applied to the periphery of the wiring board 104a to 104c.

Therefore, the grooves 112 are formed from the support plate 108 to the wiring integration board 110 on the both outer sides of the portion of the support member 107 corresponding to each bent portion of the wiring board 104a to 104c, whereby a margin is given to the supply amount of sealing resin 111 so as to sufficiently compensate for permeation of the sealing resin 111 to the back side of wiring board 104a to 104c.

In an application wherein a plurality of wiring boards 104a to 104c are mounted in parallel on one ink jet recording head, a groove is shared between adjacent wiring boards, which requires only one supply of sealing resin 111 to enhance the production efficiency. In that case, the width of the groove needs to be enough to sufficiently seal the two wiring boards.

In the present embodiment, as described above, since the grooves 112 are formed in the region of from the support plate 108 to the wiring integration board 110 and on the both outer sides of the portion of the support member 107 corresponding to each bent portion of the wiring board 104a to 104c, the margin is given to the supply amount of sealing resin 111, which can prevent sealing failure.

(Embodiment 11)

Fig. 36 is an exploded, perspective view to show the eleventh embodiment of the ink jet recording head according to the present invention and Figs. 37A and 37B are drawings to show the completely assembled state of the ink jet recording head shown in Fig. 36, wherein Fig. 37A is a perspective view of the appearance and Fig. 37B is a partly enlarged view of the cross section along 37B-37B shown in Fig. 37A.

As shown in Fig. 36 and Figs. 37A and 37B, the present embodiment is arranged by modifying the tenth embodiment in such a way that trenches 113 having the width narrower than the width of the wiring boards 104a to 104c are further provided in the portions of the support member 107 corresponding to the bent portions of the wiring boards 104a to 104c, for stabilizing the amount of the sealing resin 111 applied to the periphery of the wiring boards 104a to 104c.

In the present embodiment, the capillarity does not act in the portions where the trenches 113 are provided, so that permeation of the sealing resin 111 stops before the trenches 113. Therefore, the supply amount of seal-

ing resin 111 can be adjusted depending upon the size of trench 113, whereby the supply amount of sealing resin 111 can be decreased to the irreducible minimum.

(Embodiment 12)

Figs. 38A and 38B are drawings to show the completely assembled state of the twelfth embodiment of the ink jet recording head according to the present invention, wherein Fig. 38A is a perspective view of the appearance and Fig. 38B is a partially enlarged view of the cross section along 38B-38B shown in Fig. 38A.

As shown in Figs. 38A and 38B, the present embodiment is arranged by modifying the eleventh embodiment in such a way that the sealing resin 111 is preliminarily charged into the trenches 113, the wiring boards 104a to 104c are bent thereafter, and then the periphery of the wiring board 104a to 104c is sealed.

Since there is the clearance between the bent portion of the wiring board 104a to 104c and the support member 107 and since the recording liquid remains there most, the periphery of wiring board 104a to 104c must be sealed for certain.

In the present embodiment, the recording element units are fixed to the support member 107 and to the support plate 108 and then the electric signal input terminal side of the wiring boards 104 to 104c is connected to the wiring integration board 110; thereafter, the sealing resin 111 is preliminarily charged into the trenches 113 provided at the positions of the support member 107 corresponding to the bent portions of the wiring boards 104a to 104c and then the wiring integration board 110 is held and fixed to the support member 107; thereafter, the periphery of the bent portion of the wiring board 104a to 104c is sealed in the same manner as in the eleventh embodiment, thereby preventing the permeation of sealing resin 111 due to the capillarity.

The amount of the sealing resin 111 preliminarily charged into the trench 113 is preferably approximately equal to the volume of the trench 113.

The present embodiment uses a slightly larger amount of the sealing resin 111 than the eleventh embodiment, but the present embodiment can seal the periphery of wiring board 104a to 104c securely.

(Embodiment 13)

Figs. 39A, 39B, and 39C are drawings to show the thirteenth embodiment of the ink jet recording head according to the present invention, wherein Fig. 39A is a front view of the support member, Fig. 39B is a cross-sectional view along 39B-39B shown in Fig. 39A, and Fig. 39C is an enlarged view of the cross section along 38B-38B after completion of assembly.

The present embodiment concerns sealing around the wiring integration board 110 of the ink jet recording head shown in the tenth embodiment and grid-patterned trench 114 is provided in the portion of the support member 107 to which the wiring integration board 110 is attached. The external shape of the trench 114 is smaller than that of the wiring integration board 110, so that the entire back surface of the wiring integration board 110 can contact the support member 107.

Normally, the entire periphery of the wiring integration board 110 is sealed by the sealing resin 111 without clearance in order to prevent permeation of the recording liquid to the back surface. When the trench 114 is provided inside the portion of the support member 107 in contact with the back surface of the wiring integration board 110, the sealing resin 111 supplied to the periphery of the wiring integration board 110 permeates by capillarity into only the portions where the wiring integration board 110 is in contact with the support member 107, and the permeation stops before the trench 114.

This can stabilize the amount of the sealing resin 111 applied to the periphery of the wiring integration board 110.

With the arrangement of the grid-patterned trench 114, even if there is a defect in the sealing of the periphery of the wiring integration board 110 and even if the recording liquid permeates to the back surface of the wiring integration board 110, the recording liquid will be apt to remain in the trench 114 and will thus be prevented from permeating to the back surface of the wiring board 104.

Further, if the trench 114 is divided into trench 114a adjacent to the periphery of the support member 107 and trench 114b located inside and if they are isolated from each other as shown in Figs. 39A to 39C, the permeation of recording liquid can be prevented more reliably.

Islands 115 formed in the grid-patterned trench 114 are effective in eliminating flexure of the wiring integration board 110 against the external force such as contact pressure of the output terminal for supplying the electric signal to the wiring integration board 110, thus improving electric connection.

In the present embodiment as described above, the grid-patterned trench 114 is provided in the portion of the support member 107 to which the wiring integration board 110 is attached and the entire periphery of the wiring integration board 110 is sealed by the sealing resin 111, whereby the recording liquid can be prevented from permeating to the back surface of the wiring integration board 110 and wiring board 104.

(Embodiment 14)

The wiring integration board 207 in Embodiments 9 to 13 described above is often fixed to the support member 203 by the method of adhesive, double coated tape, thermal welding, or the like, but high position accuracy is required for the electric signal input terminal 206 of the wiring integration board 207 for contact with the external output terminal (not illustrated). Therefore, as shown in Fig. 50, it is normal to fix the wiring integration

board 207 to the support member 203 by positioning the wiring integration board 207 by pins 209 and thereafter fusing the pins 209 by heat, which is advantageous in aspects of the cost and manufacturing tactics.

In the above-stated method for securing the wiring integration board to the support member by the pins, however, the diameter of each pin is set to be close to the diameter of an insertion hole in the wiring integration board corresponding to the pin, for assuring the position accuracy of wiring integration board. When the wiring integration board is coupled with the pin, they touch each other to make burr 240 and the burr 240 is deposited on the back surface of the wiring integration board 207 as shown in Fig. 51, which weakens adhesion between the wiring integration board 207 and the support member 203. When the wiring integration board is fixed in such an unstable state in this way, electrical conduction becomes unstable at the contact between the electric signal input terminal on the wiring integration board and the external output terminal, which poses a problem of contact failure.

In view of the problem in the conventional technology as described above, the present embodiment provides a highly reliable ink jet recording head for positioning and securing the wiring integration board to the support member, which is free of the trouble due to production of burr during assembly, in which the wiring integration board is adhered and fixed to the support member for certain, and which is free of the electrical contact failure at the contact between the input terminal of wiring integration board and the external output terminal.

Fig. 40 is an exploded, perspective view of the fourteenth embodiment of the ink jet recording head according to the present invention. The ink jet recording head of the present embodiment has three recording element boards 201 in each of which a plurality of recording elements for supplying the energy for ejecting the ink are arrayed; wiring boards 204a, 204b, 204c, connected to the respective recording element boards 201, for supplying the electric signal for ejecting the ink; electric signal input terminals 205 for capturing the electric signal into the respective wiring boards 204a, 204b, 204c; wiring integration board 207 for integration of common input terminals in the plural wiring boards 204a, 204b, 204c; electric signal input terminal 206, provided in the wiring integration board 207, for input of electric signal from the external output terminal (not illustrated); support member 203 for securing the recording element boards 201, the wiring boards 204a, 204b, 204c, and the wiring integration board 207, in which ink flow paths from the ink tanks (not illustrated) are formed; insertion holes 208 and pins 209 for securing the wiring integration board 207 to the support member 203; and grooves 211 for catch of burr 210 described below with the drawing.

The recording element boards 201 are normally fabricated in such a way that the heating resistor layer, wirings, etc. are patterned on a silicon wafer by the photolithography technology, nozzles as flow paths and ejection outlets (orifices) ar made of a photosensitiv resin, and the silicon wafer is cut. Then the recording element boards 201 are connected to the respective wiring boards 204a, 204b, 204c for receiving the electric signal by the TAB mounting technology. Normally, one wiring board is provided with approximately thirty electric signal input terminals 205 for input of electric signal from the outside to the recording element board 201, but, in order to decrease the number of electric contacts with the outside, the all electric signal input terminals 205 of the wiring boards 204a, 204b, 204c are electrically connected and fixed to the wiring integration board 207 and common electric signal input terminals out of the plural wiring boards 204a, 204b, 204c are integrated at the electric signal input terminal 206 on the wiring integration board 207. The wiring integration board 207 is fixed to the support member 203 by thermal welding described below.

Fig. 41 is a cross-sectional view before assembly of the pin 209 provided in the support member 203 and the insertion hole 208 of the wiring integration board 207 to be associated with the pin 209. In Fig. 41, the groove 211 for catching the burr produced upon assembly, described hereinafter with Fig. 42, is provided around the root of pin 209. The position accuracy of the wiring integration board 207 relative to the support member 203 needs to be in the range of approximately 0.1 mm from the positional relation between the electric signal input terminal 206 of wiring integration board 207 and the external output terminal side connected thereto, which is determined by the insertion hole 208 (of the diameter 1.3 mm) and the pin 209 (of the diameter 1.2 mm).

Fig. 42 is a cross-sectional view after completion of assembly of the insertion hole 208 and pin 209 shown in Fig. 41. As shown in Fig. 42, the wiring integration board 207 is fixed to the support member 203 by inserting the pin 209 into the insertion hole 208 and fusing the head of pin 209 by heat to crush it (thermal welding). While the pin 209 is inserted into the insertion hole 208, the pin 209 molded of a molding material is shaved to produce the fine burr 210 and the burr adheres to around the insertion hole 208 on the back surface side of the wiring integration board 207. Since the groove 211 is provided around the root of pin 209, the burr 210 drops into the groove 211 as shown in Fig. 42, whereby the wiring integration board 207 comes to contact the support member 203 perfectly. The groove 211 can be made readily by forming a projection in the mold for injection molding of the support member 203 of the molding material. By securing the support member 203 in close contact to the wiring integration board 207 in this way, no electric contact failure occurs at the contact between the electric signal input terminal 206 of the wiring integration board 207 and the external output terminal.

(Embodiment 15)

Fig. 43 is an exploded, perspective view of the fifteenth embodiment of the ink jet recording head according to the present invention. Fig. 44 is a cross-sectional view before assembly of a pin of the support member in Fig. 43 and an insertion hole of the wiring integration board associated therewith, and Fig. 45 is a cross-sectional view after completion of assembly of the pin and insertion hole shown in Fig. 44. In these figures, the same reference symbols denote the same components as those in Embodiment 14, and only different components from Embodiment 14 will be described.

The present embodiment is constructed in such structure that chamfer 212 is provided on the back surface side (the surface side in contact with the support member 203) of the insertion hole 208 in the wiring integration board 207 as shown in Fig. 43 and Fig. 44, and there is no specific groove around the root of pin 209, different from Embodiment 14.

In this arrangement, as shown in Fig. 45, the wiring integration board 207 is fixed to the support member 203 by inserting the pin 209 into the insertion hole 208 and fusing the head of pin 209 by heat to crush it in the same manner as in Embodiment 14. With provision of the chamfer 212, the pin 209 molded of the molding material is shaved during insertion of the pin 209 into the insertion hole 208 to produce the fine burr 220 and the burr 220 adheres to around the chamfer 212 on the back surface side of the wiring integration board 207. Accordingly, the burr 220 is collected into the chamfer 212 as shown in Fig. 45, whereby the wiring integration board 207 comes to closely contact the support member 203 perfectly. The chamfer 212 can be formed readily by performing an additional work upon router working of the contour of the wiring integration board 207. By securing the wiring integration board 207 in close contact to the support member 203 in this way, it becomes possible to eliminate the electrical contact failure at the contact between the electric signal input terminal 206 of the wiring integration board 207 and the external output terminal.

(Embodiment 16)

Fig. 46 is an exploded, perspective view of the sixteenth embodiment of the ink jet recording head according to the present invention. Fig. 47 is a cross-sectional view before assembly of a pin of the support member and an insertion hole of the wiring integration board associated therewith, shown in Fig. 46, and Fig. 48 is a top plan view of Fig. 47 to show the shape of the pin and the positional relation between the insertion hole and the pin. Fig. 49 is a cross-sectional view after completion of assembly of the pin and insertion hole shown in Fig. 47. In these figures, the same reference symbols also denote the same components as those in Embodiment 14, and only different components from Embodiment 14 will be described.

In the present mbodiment the pin 209 is of a polygonal prism shape and the present embodiment shows an example of a hexagonal prism, as shown in Fig. 46, Fig. 47, and Fig. 48. There is no special groove provided around the root of pin 209, different from Embodiment 14.

In this arrangement, as shown in Fig. 49, the wiring integration board 207 is fixed to the support member 203 by inserting the pin 209 into the insertion hole 208 and fusing the head of pin 209 by heat to crush it in the same manner as in Embodiment 14. The pin 209 molded of the molding material is shaved during insertion of the pin 209 into the insertion hole 208 to produce fine burr 230. However, the pin 208 is formed in the polygonal prism shape whereby the insertion hole 208 contacts only the corners of the pin 209, so that an amount of burr 230 produced is decreased and so that the burr 230 is collected in the clearance between the insertion hole 208 and the pin 209 as shown in Fig. 49. Accordingly, the wiring integration board 207 can be perfectly in close fit with the support member 203. By securing the wiring integration board 207 in close contact to the support member 203 in this way, it becomes possible to eliminate the electrical contact failure at the contact between the electric signal input terminal 206 of the wiring integration board 207 and the external output terminal.

The above embodiments were described with the examples of the side shooter type, but without having to be limited to this type, the present invention may also be applied to heads of the edge shooter type.

An ink jet recording head comprises a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open, a support member having a first joint surface joined to the joined surface in the main body section and a second joint surface disposed opposite to the first joint surface, the support member having a communicating passage in communication with the one end of the ink supply passage, and a recording element board comprising an ink heating portion disposed on the second joint surface of the support member and arranged to heat the ink supplied through the communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed, wherein thermal properties in materials of the recording element board and the support member are of the same quality.

Claims

1. An ink jet recording head comprising:

   a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open;

a support member having a first joint surface joined to the joined surface in said main body section and a second joint surface disposed opposite to the first joint surface, said support member having a communicating passage in communication with the one end of said ink supply passage; and

a recording element board comprising an ink heating portion disposed on the second joint surface of said support member and arranged to heat the ink supplied through said communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed;

wherein thermal properties in materials of said recording element board and said support member are of the same quality.

2. An ink jet recording head according to Claim 1, wherein the thermal properties in the materials of said recording element board and said support member are coefficients of linear expansion.

3. An ink jet recording head according to Claim 1, wherein the thermal properties in the materials of said recording element board and said support member are thermal conductivities.

4. An ink jet recording head according to Claim 1, wherein coefficients of linear expansion in the materials of said recording element board and said support member are substantially equal and a thermal conductivity in the material of the support member is larger than a thermal conductivity of the material of the recording element board.

5. An ink jet recording head according to Claim 1, wherein the communicating passage in said support member comprises a plurality of communicating passages.

6. An ink jet recording head according to Claim 1, wherein an aperture area of the Communicating passage in said support member is smaller than an aperture area of the ink supply port of said recording element board for introducing the ink supplied through the communicating passage.

7. An ink jet recording head according to Claim 1, wherein a thickness of said support member is larger than a thickness of said recording element board.

8. An ink jet recording head according to Claim 1, wherein the materials of said recording element board and said support member are selected from the group consisting of silicon, alumina, aluminum nitride, silicon carbide, molybdenum, and tungsten.

9. An ink jet recording head comprising:

a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open;

a first support member having a first joint surface joined to the joined surface in said main body section and a second joint surface disposed opposite to the first joint surface, said support member having a communicating passage in communication with the one end of said ink supply passage;

a second support member joined to the second joint surface of said first support member; and

a recording element board comprising an ink heating portion disposed inside said second support member, joined to the second joint surface of said first support member, and arranged to heat the ink supplied through said communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed.

10. An ink jet recording head according to Claim 9, wherein the first joint surface of the first support member is bonded to the joined surface of said main body section with a first adhesive, the second joint surface of the first support member is bonded to said second support member with a second adhesive, and said recording element board is bonded to the second joint surface in the first support member with a third adhesive.

11. An ink jet recording head according to Claim 10, wherein said first adhesive is an adhesive with elasticity, said second adhesive is an adhesive with a relatively large thermal conductivity, and the third adhesive is an adhesive with relatively high rigidity.

12. An ink jet recording head according to Claim 9, wherein said second support member has a bent portion to be received in said main body section.

13. An ink jet recording head according to Claim 9, wherein a recess for holding an adhesive is provided in the joined surface of said main body section.

14. An ink jet recording head according to Claim 9, further comprising a wiring board electrically connected to the recording element board, wherein clearance between said wiring board and said recording element board is sealed by an adhesive with elasticity.

15. An ink jet recording head according to Claim 9, wherein a material of said first support member is one selected from the group consisting of silicon, alumina, aluminum nitride, silicon carbide, silicon nitride, molybdenum, and tungsten and a material of the main body section is a resin.

16. An ink jet recording head comprising:

a main body section having a joined surface in which one end of an ink supply passage for introducing ink from an ink reserving portion is open;
a first support member having a first joint surface joined to the joined surface in said main body section and a second joint surface disposed opposite to the first joint surface, said support member having a communicating passage in communication with the one end of said ink supply passage;
a second support member joined to the second joint surface of said first support member; and
a plurality of recording element boards, each recording element board comprising an ink heating portion disposed inside said second support member, joined to the second joint surface of said first support member, and arranged to heat the ink supplied through said communicating passage, and an ink ejection outlet forming portion in which an ink ejection outlet for ejecting the ink heated by the ink heating portion is formed;

wherein thermal properties in a material of said first support member and a material of said recording element boards are of the same quality.

17. An ink jet recording head according to Claim 16, wherein a thermal conductivity of the material of the first support member is substantially equal to a thermal conductivity of the material of said recording element boards.

18. An ink jet recording head according to Claim 16, wherein a total length of said first support member along an array direction of said recording element boards is larger than a total length of an array of the plurality of recording element boards.

19. An ink jet recording head comprising:

a plurality of recording element units, each recording element unit comprising a recording element board having a plurality of recording elements for ejecting a recording liquid and a supply port, provided in a surface opposite to a surface in which the recording elements are provided, for supplying said recording liquid to said recording elements, and a wiring board having an opening portion for the recording element board to be set therein, said wiring board being connected to said recording element board, thereby applying an electric pulse for ejecting the recording liquid to said recording element board;
a support member for holding and securing said recording element boards; and
a support plate having an opening portion for contact of said recording element boards with said support member and interposed between said wiring boards and said support member, thereby holding and securing said wiring boards;

wherein a resin fills a portion where said recording element boards are not placed, in the opening portion of said support plate.

20. An ink jet recording head according to Claim 19, wherein the opening portion of said support plate is larger than the opening portion of said wiring board.

21. An ink jet recording head according to Claim 19, wherein said resin has water repellency.

22. An ink jet recording head according to Claim 20, wherein a resin fills a surface of a portion of said support plate where said recording element units are not placed.

23. An ink jet recording head according to Claim 22, wherein said resin has water repellency.

24. An ink jet recording head comprising:

a plurality of recording element units, each recording element unit comprising a recording element board having a plurality of recording elements for ejecting a recording liquid and a supply port, provided in a surface opposite to a surface in which said recording elements are provided, for supplying said recording liquid to said recording elements, and a wiring board for applying an electric pulse for ejecting said recording liquid to the recording element board;
a wiring integration board for electrically connecting said plurality of wiring boards with each other; and
a support member for holding and securing said plurality of wiring boards in a partly bent state and for holding and securing said wiring integration board at a predetermined angle relative to said recording element boards;
in which areas around bent portions of said wiring boards are sealed by a resin;

wherein said support member has grooves of a predetermined length on both

outer sides of portions thereof corresponding to the bent portions of said wiring boards.

25. An ink jet recording head according to Claim 24, wherein said support member has trenches having a width narrower than said wiring boards, in the portions thereof corresponding to the bent portions of said wiring boards.

26. An ink jet recording head according to Claim 25, wherein the inside of said trenches is preliminarily filled with a resin.

27. An ink jet recording head comprising:

a plurality of recording element units, each recording element unit comprising a recording element board having a plurality of recording elements for ejecting a recording liquid and a supply port, provided in a surface opposite to a surface in which said recording elements are provided, for supplying said recording liquid to said recording elements, and a wiring board for applying an electric pulse for ejecting said recording liquid to the recording element board;
a wiring integration board for electrically connecting said plurality of wiring boards with each other; and
a support member for holding and securing said plurality of wiring boards in a partly bent state and for holding and securing said wiring integration board at a predetermined angle relative to said recording element boards;
in which an area around said wiring integration board is sealed by a resin;
wherein said support member has a grid-patterned trench in a portion thereof where said wiring integration board is fixed.

28. An ink jet recording head according to Claim 27, wherein said trench is divided into a trench located adjacent to the periphery of said support member and a trench located inside and wherein said trenches are isolated from each other.

29. An ink jet recording head comprising:

a plurality of recording element units in each of which a wiring board is connected to a recording element board in which a plurality of recording elements for supplying energy for ejecting a recording liquid are arrayed; a wiring integration board for electrically connecting said recording element units with each other, said wiring integration board having an input terminal for input of an electric signal from the outside; and a pin for positioning and securing said input terminal of the wiring integration board and an external output terminal; in which said wiring integration board is positioned and secured to the support member by said pin;
wherein a groove is formed around the root of said pin.

30. An ink jet recording head according to Claim 29, wherein an insertion hole of said pin in said wiring integration board is chamfered.

31. An ink jet recording head according to Claim 29, wherein said pin is of a polygonal prism shape.

32. An ink jet recording head according to Claim 29, wherein said recording elements are electrothermal transducers for generating thermal energy utilized for ejecting a droplet of the recording liquid.

33. An ink jet recording head according to Claim 32, wherein the droplet of the recording liquid is ejected from an ejection outlet by making use of film boiling caused by the thermal energy applied by said electrothermal transducer.

FIG. 1

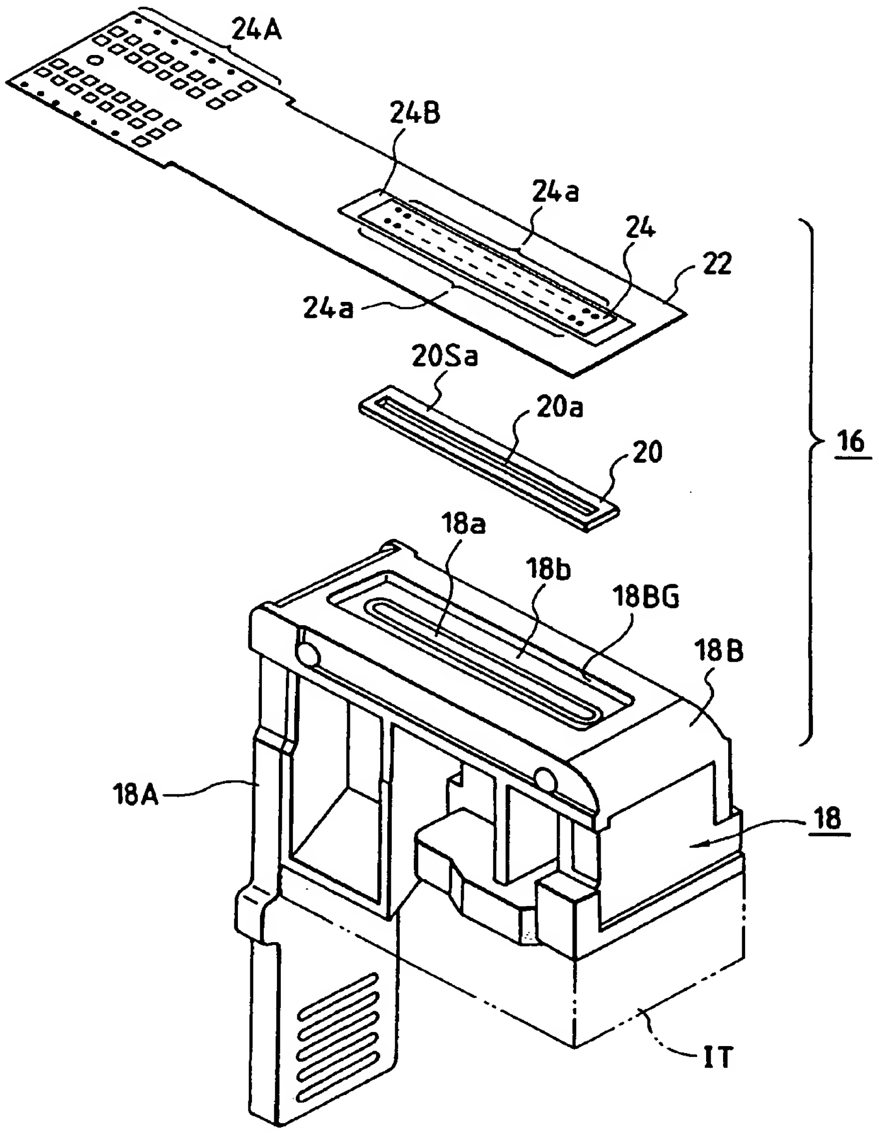


FIG. 2A

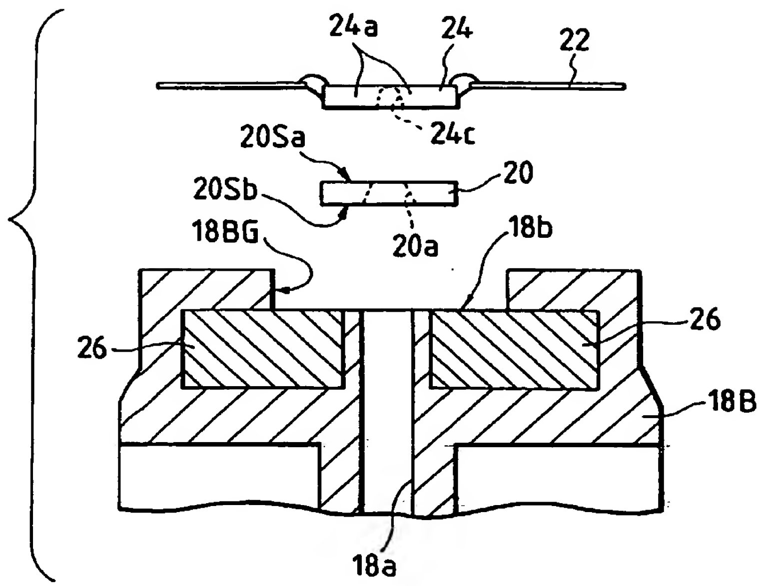

24a
24
22
24c
20Sa
20
20Sb
20a
18BG
18b
26
26
18B
18a

FIG. 2B

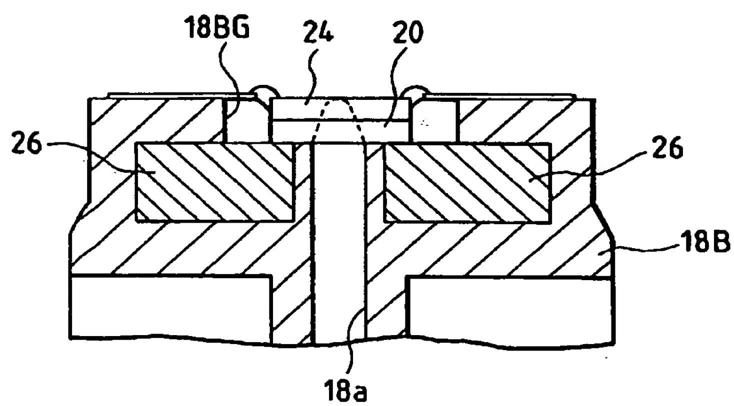

18BG
24
20
26
26
18B
18a

FIG. 3A

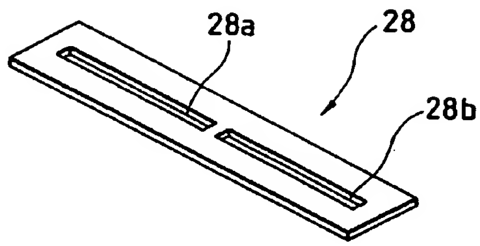


FIG. 3B

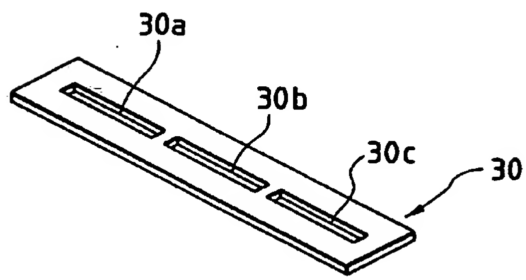


FIG. 3C

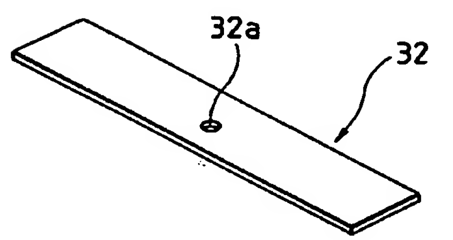


FIG. 4

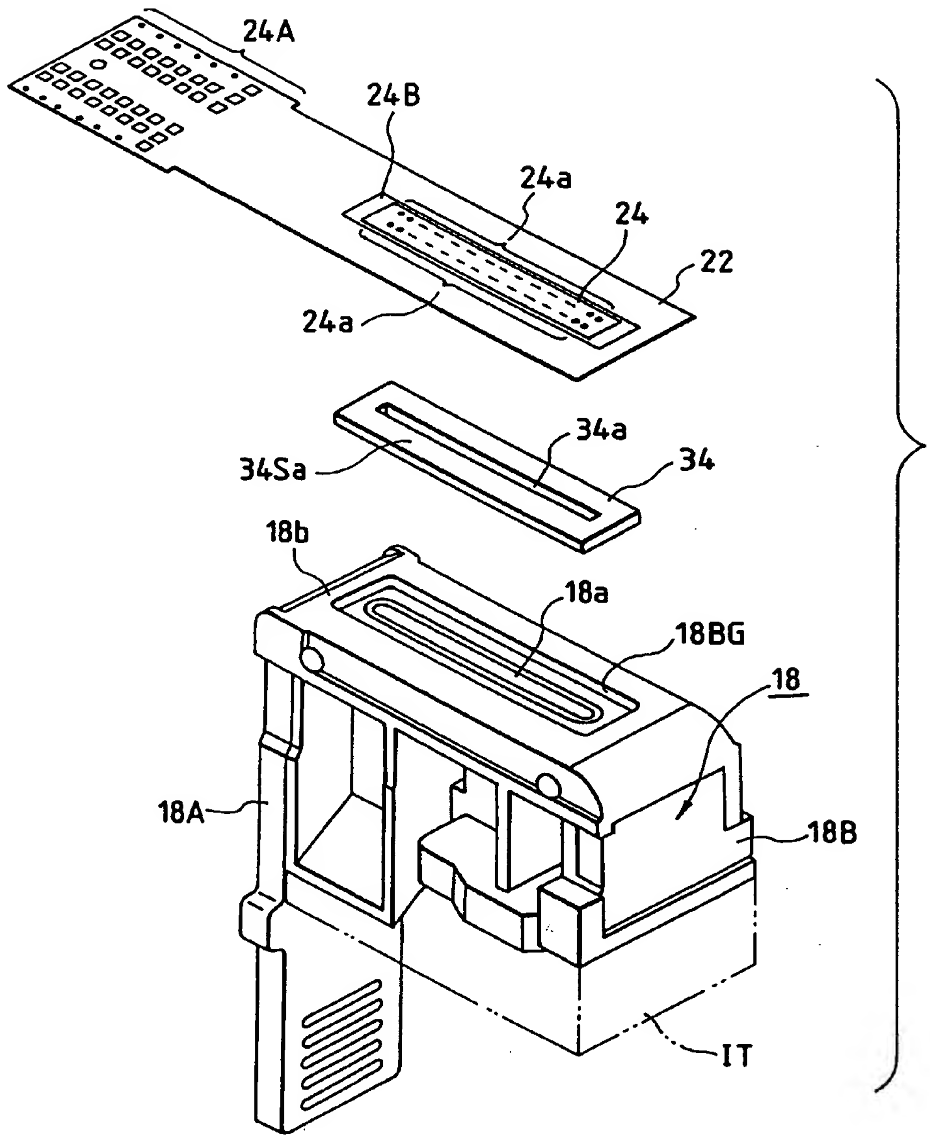


FIG. 5A

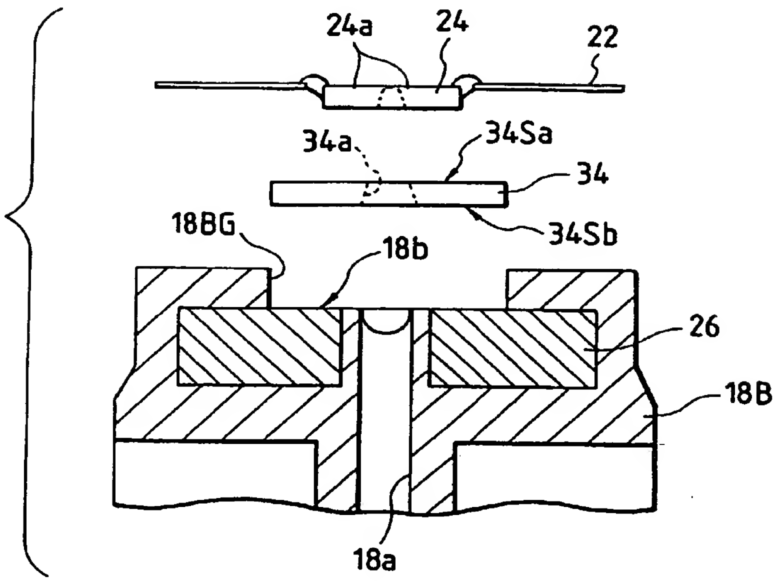


FIG. 5B

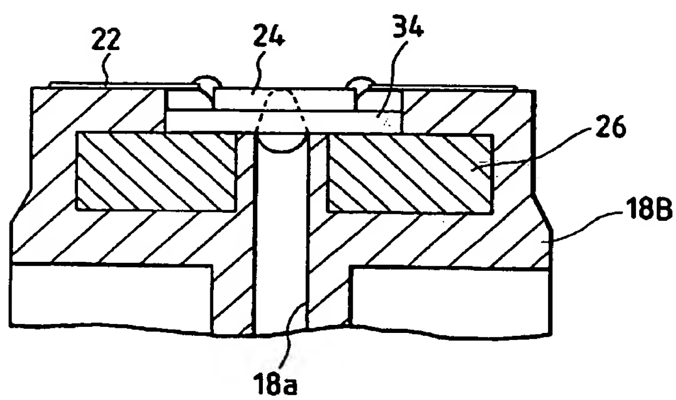


FIG. 6A

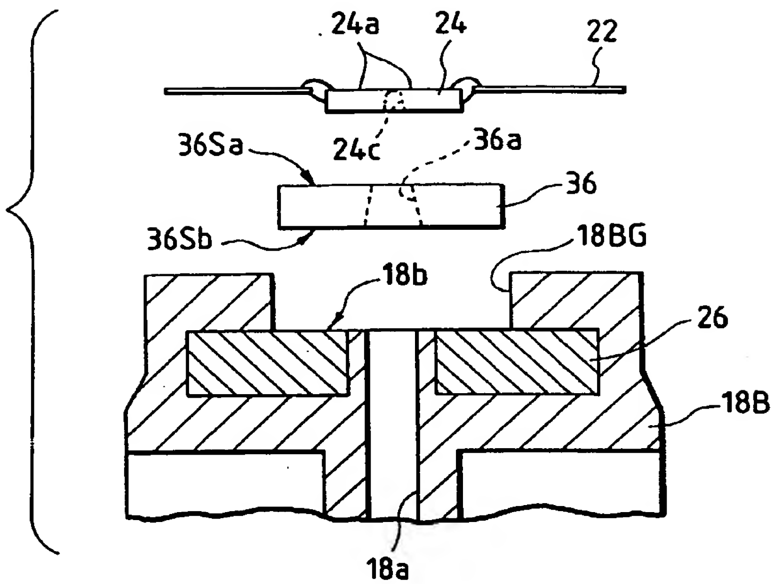

24a
24
22
24c
36Sa
36a
36
36Sb
18BG
18b
26
18B
18a

FIG. 6B

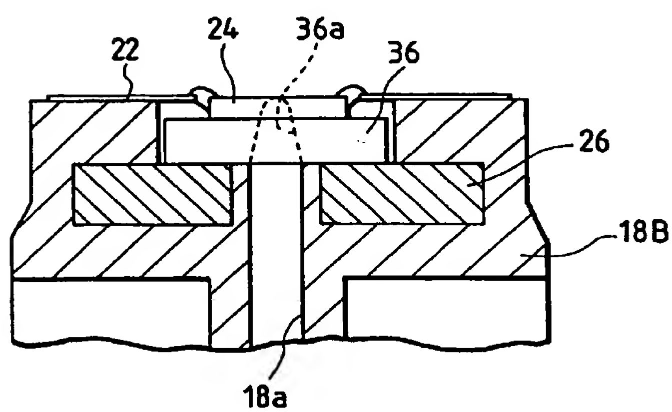

22
24
36a
36
26
18B
18a

FIG. 7

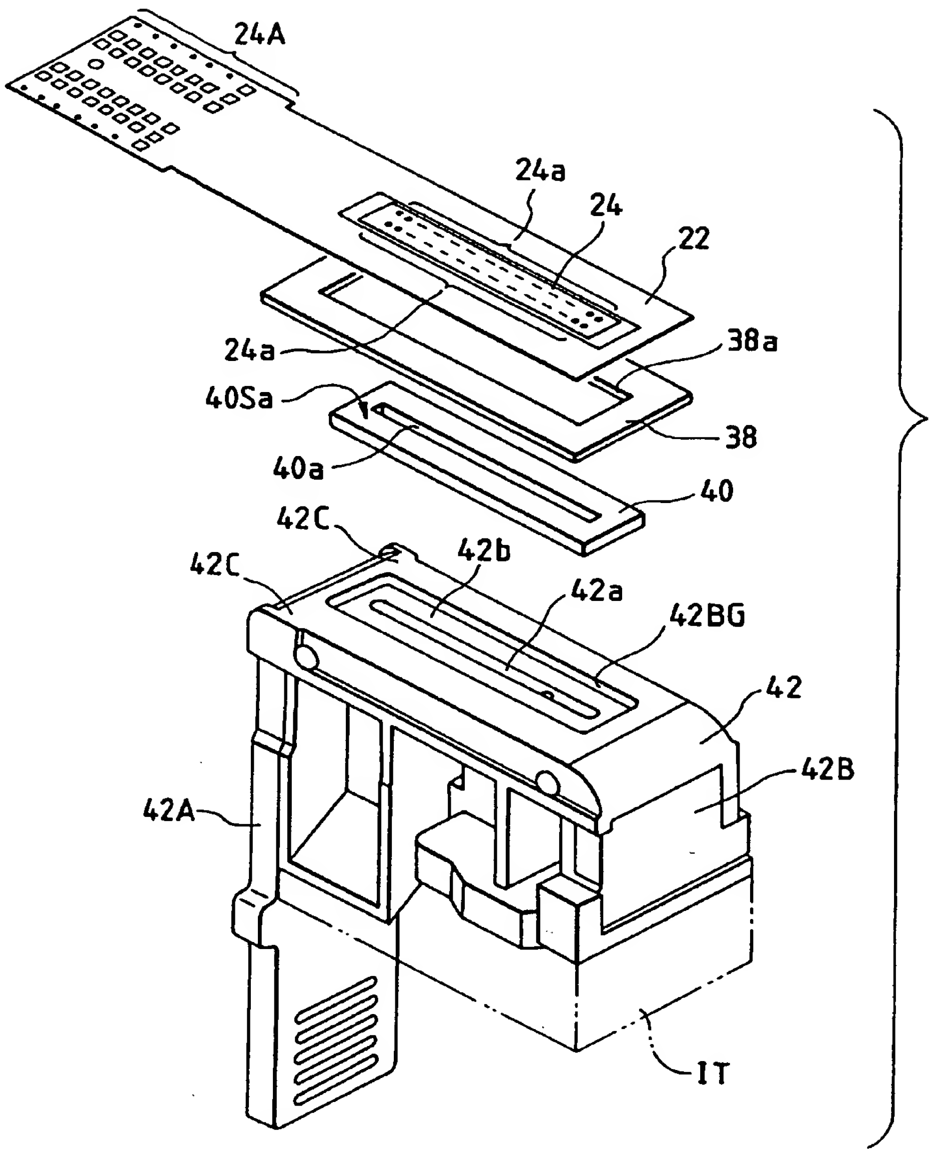

24A
24a
24
22
24a
38a
40Sa
38
40a
40
42C
42C
42b
42a
42BG
42
42B
42A
IT

FIG. 8A

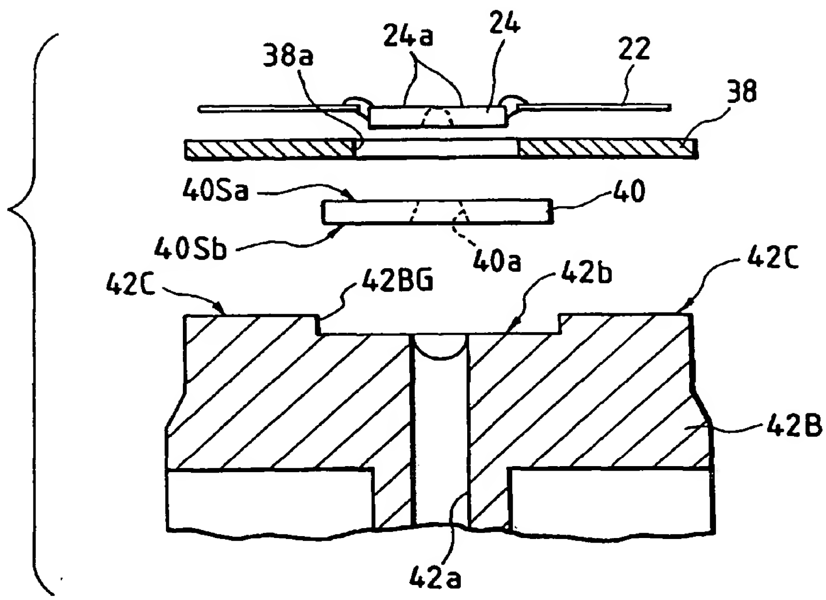

24a
24
38a
22
38
40Sa
40
40Sb
40a
42C
42BG
42b
42C
42B
42a

FIG. 8B

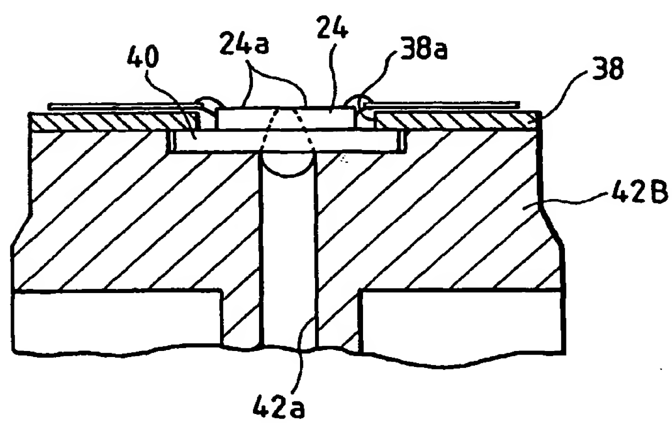

24
40
24a
38a
38
42B
42a

FIG. 9A

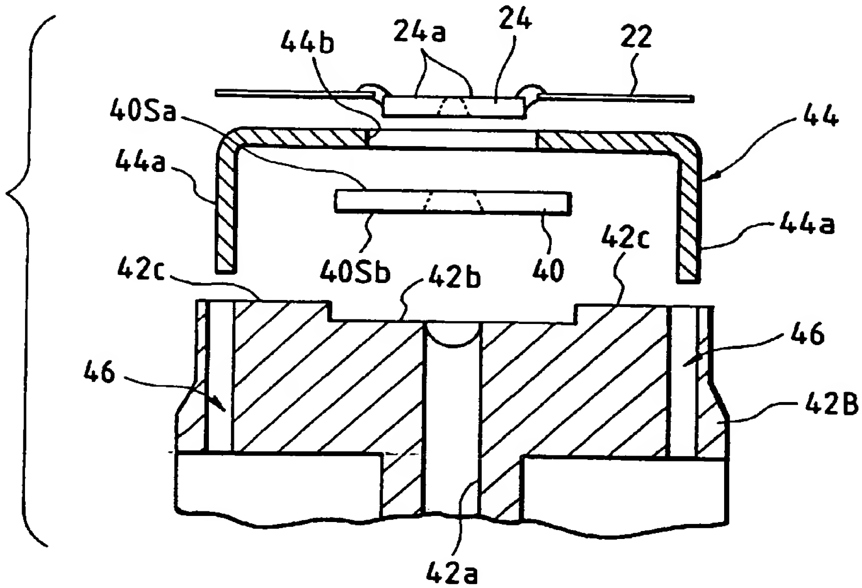

44b
24a
24
22
40Sa
44
44a
44a
40Sb
42b
40
42c
42c
46
46
42B
42a

FIG. 9B

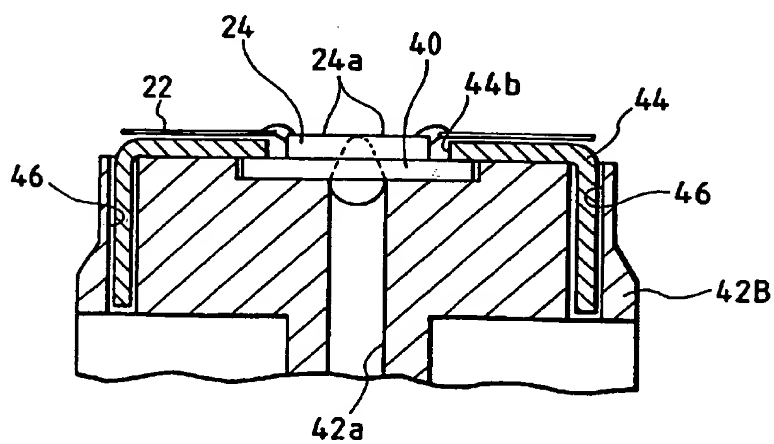

24
24a
40
22
44b
44
46
46
42B
42a

FIG. 10A

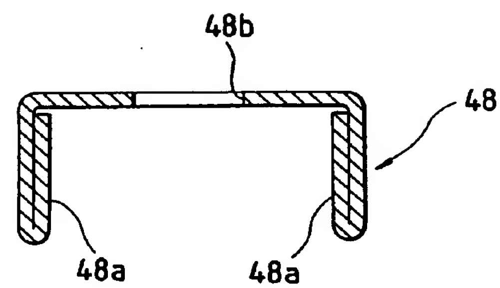


FIG. 10B

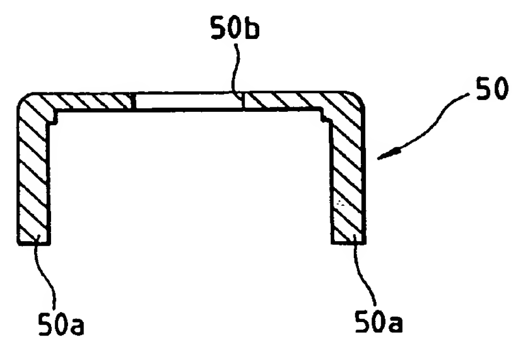


FIG. 11

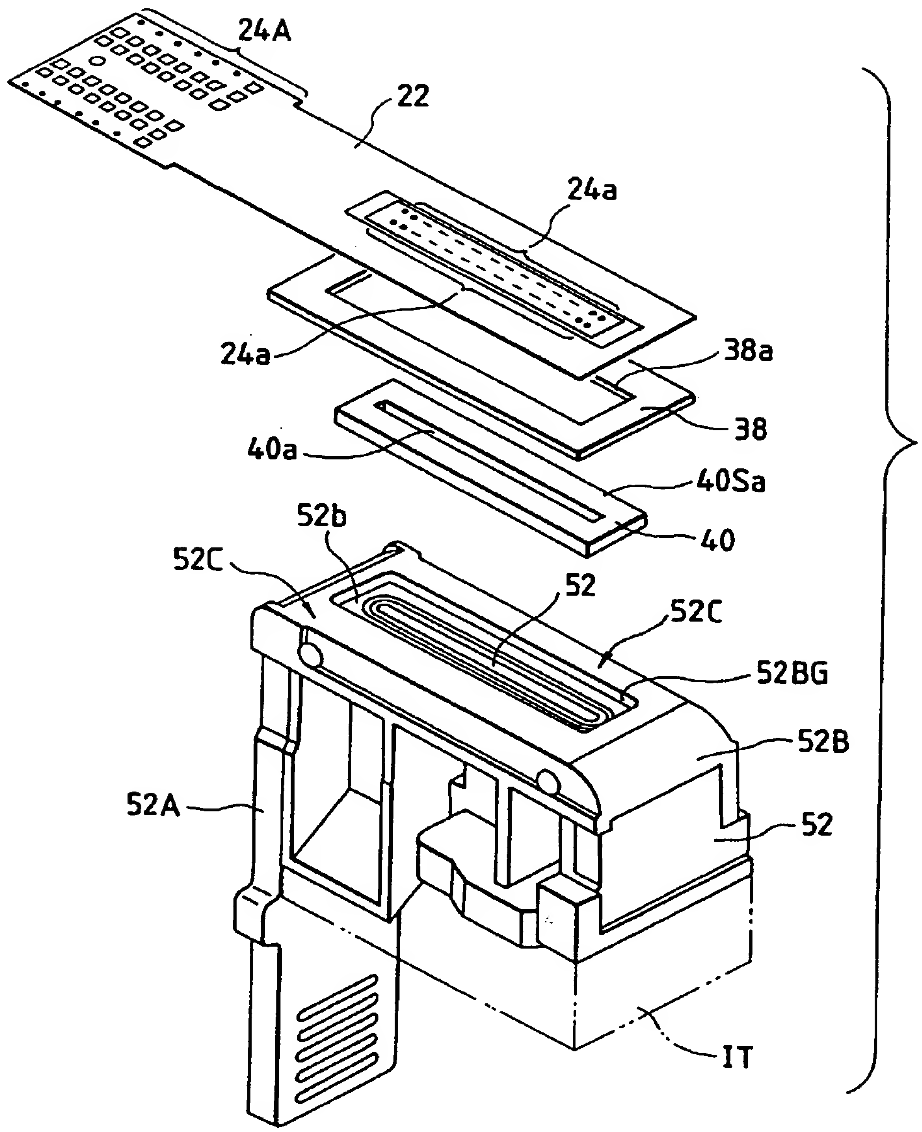

24A
22
24a
24a
38a
38
40a
40Sa
40
52b
52C
52
52C
52BG
52B
52A
52
IT

FIG. 12A

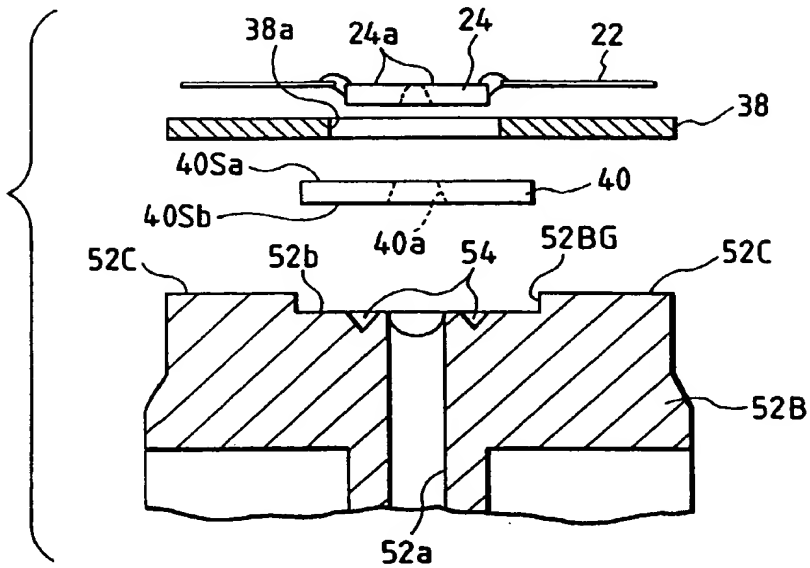


FIG. 12B

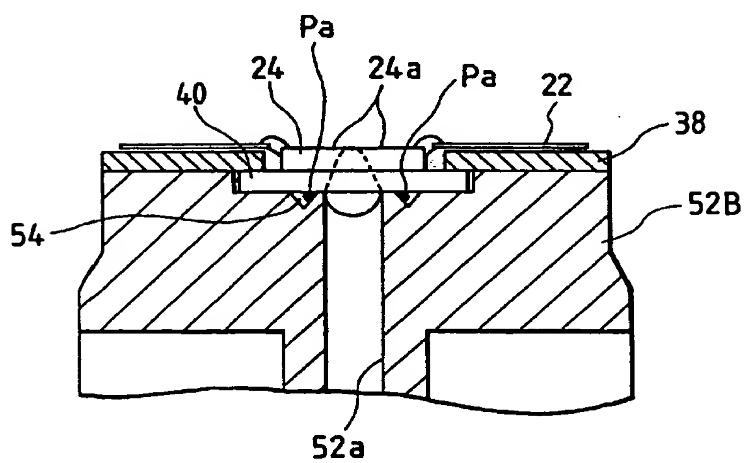


FIG. 13

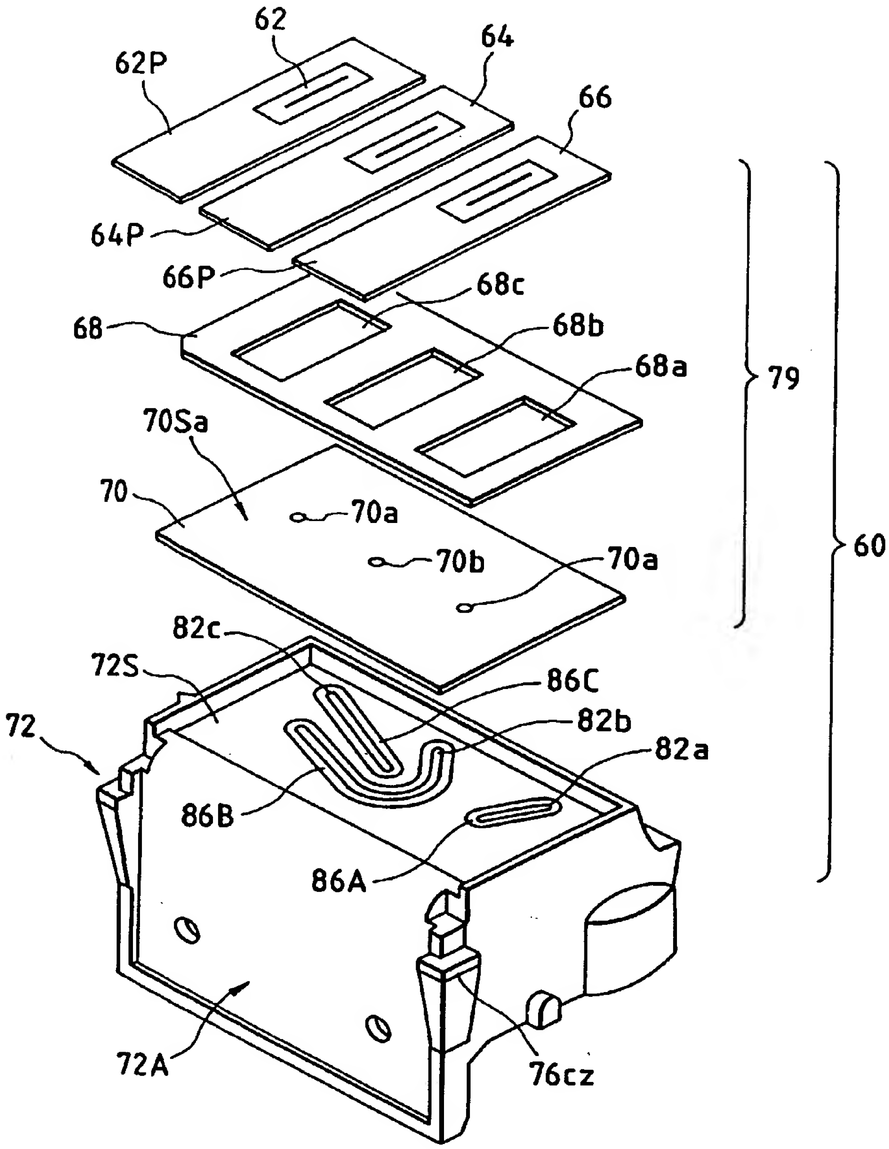

62
62P
64
66
64P
66P
68c
68
68b
68a
79
70Sa
70
70a
70b
70a
60
82c
72S
86C
82b
72
82a
86B
86A
72A
76cz

FIG. 14

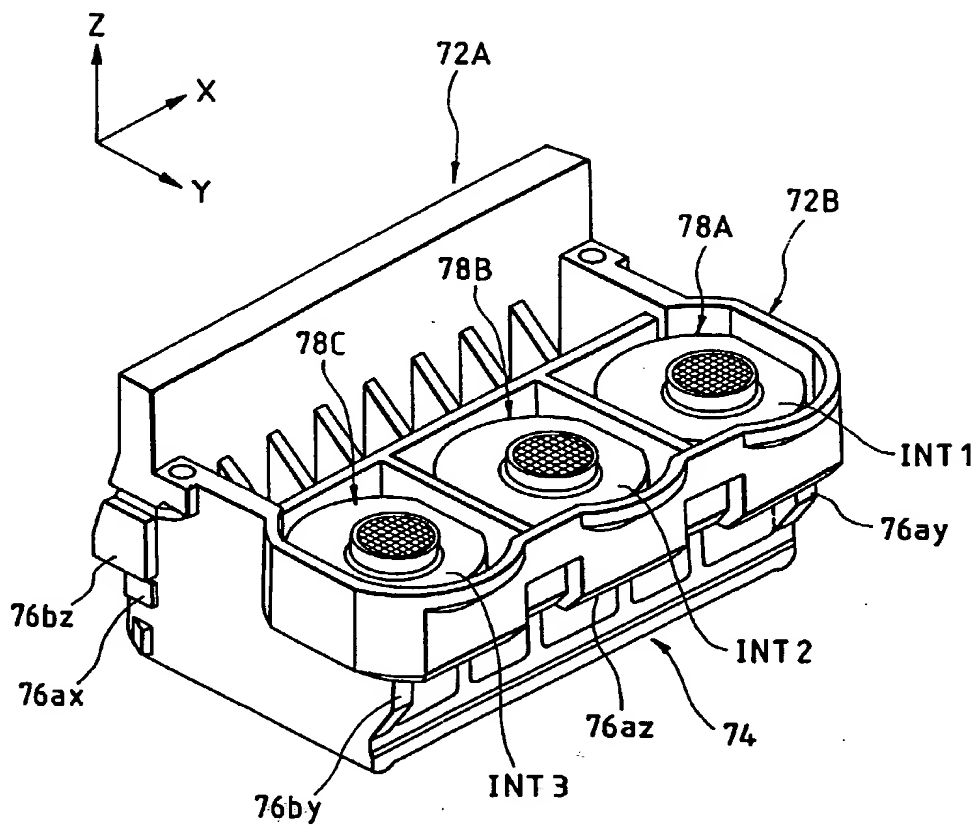

Z
X
Y
72A
72B
78A
78B
78C
INT 1
76ay
76bz
INT 2
76ax
76az
74
INT 3
76by

FIG. 15

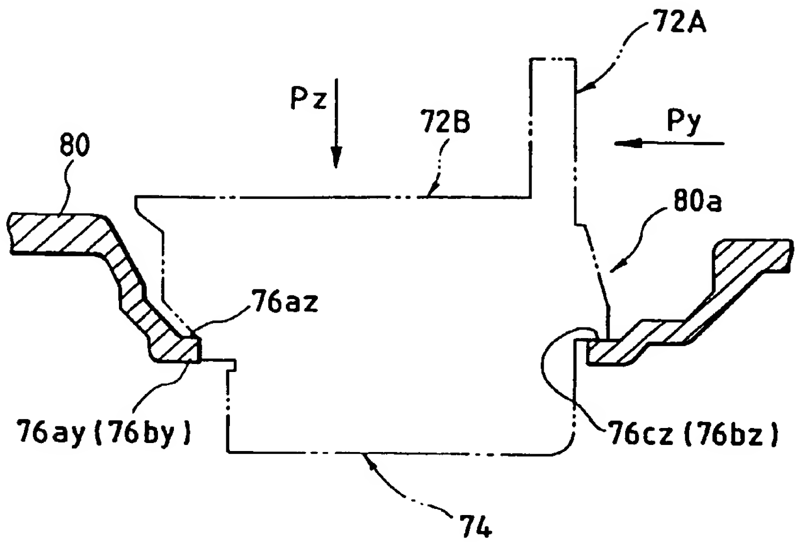

72A
Pz
72B
Py
80
80a
76az
76ay (76by)
76cz (76bz)
74

FIG. 16

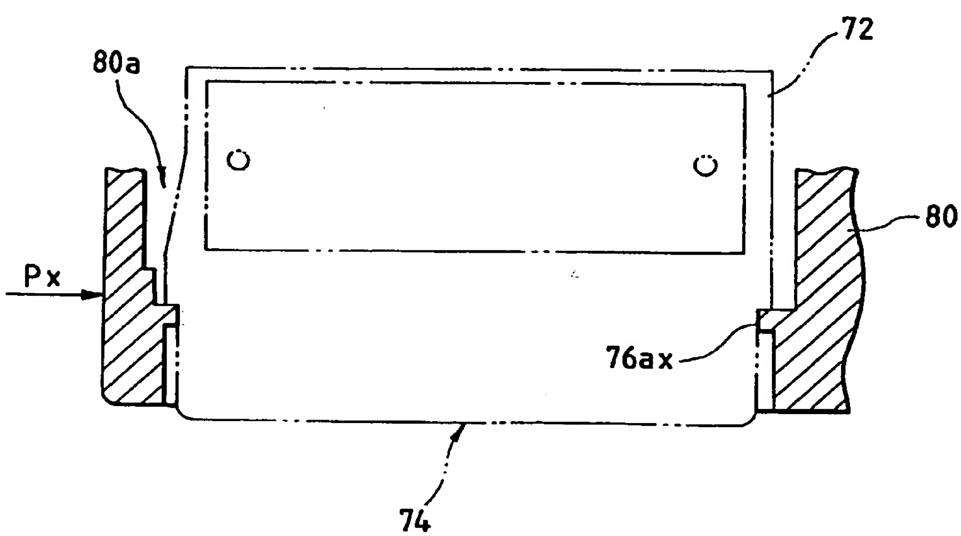

72
80a
80
Px
76ax
74

FIG. 17

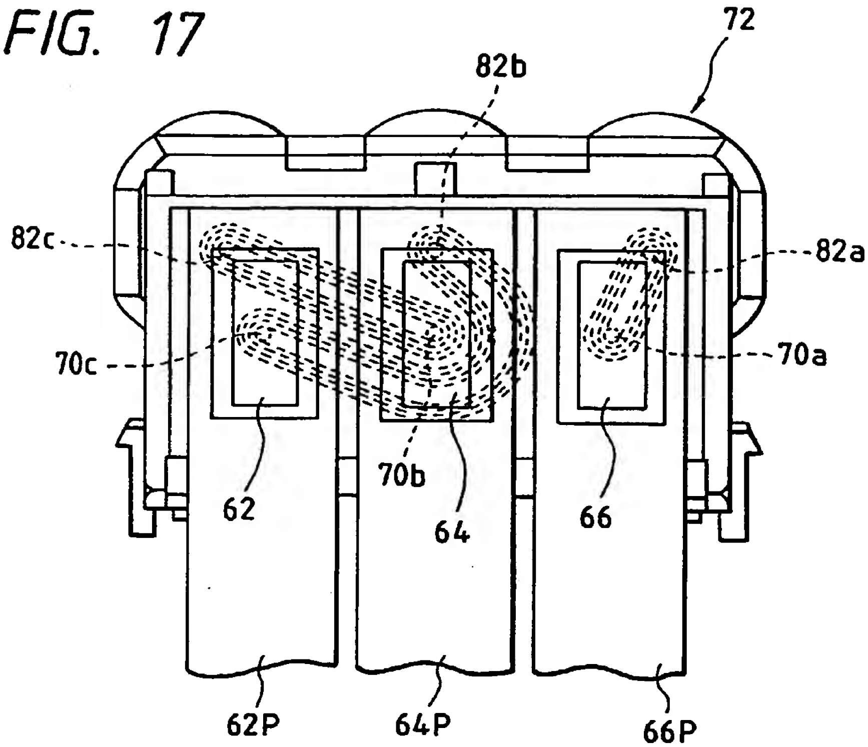

72
82b
82c
82a
70c
70a
70b
62
64
66
62P
64P
66P

FIG. 18

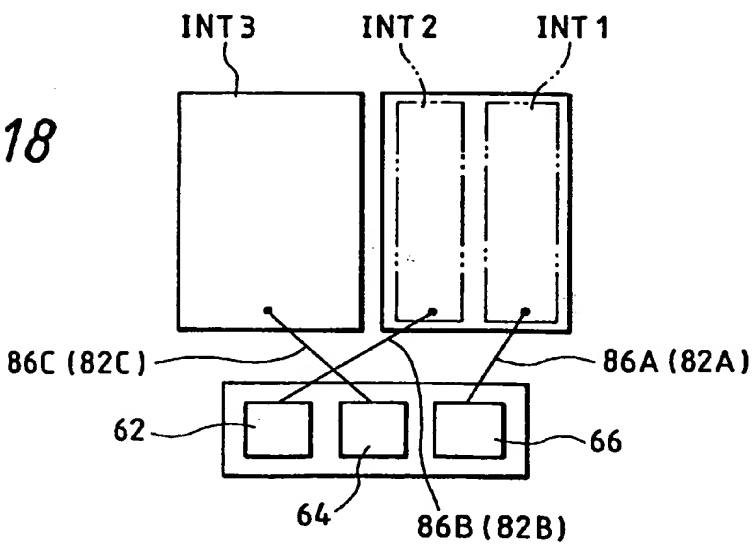

INT 3
INT 2
INT 1
86C (82C)
86A (82A)
62
66
64
86B (82B)

FIG. 19

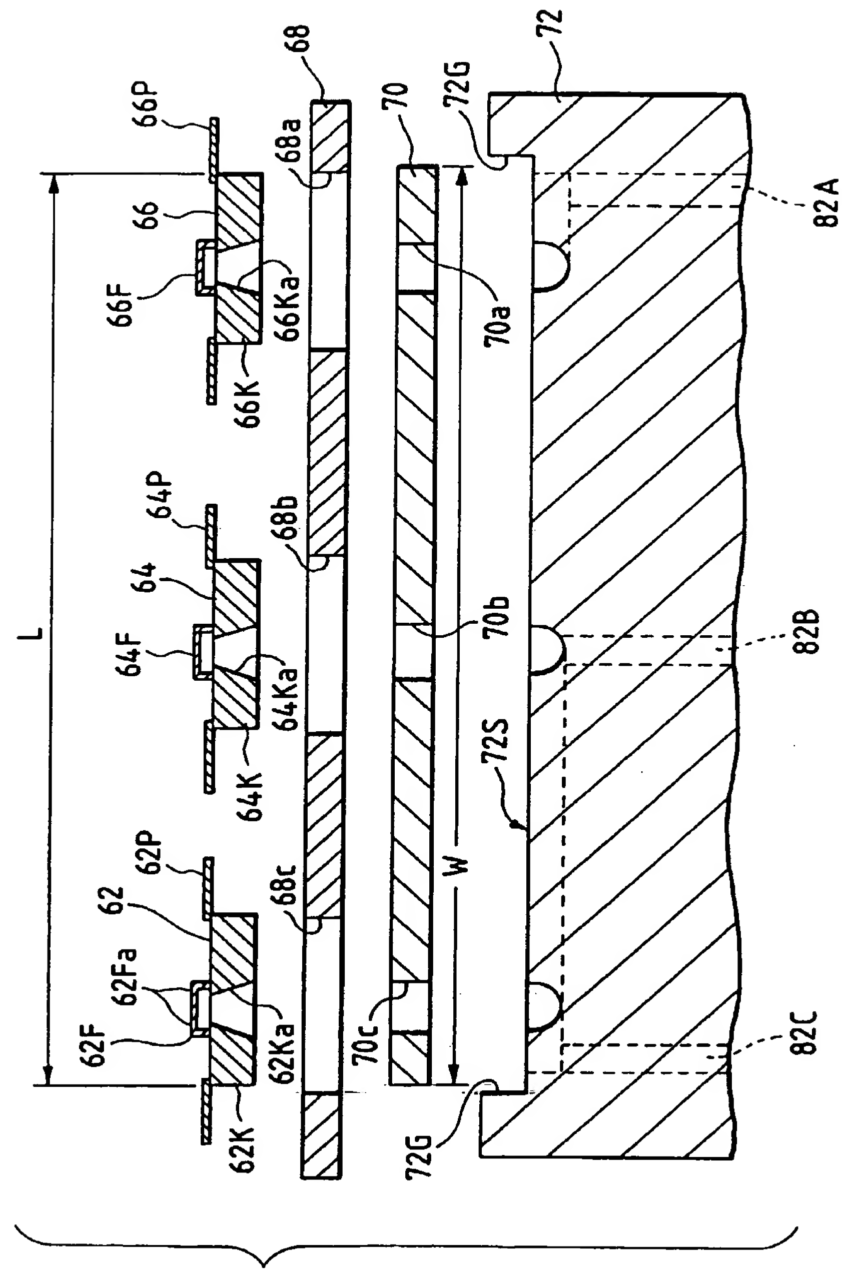
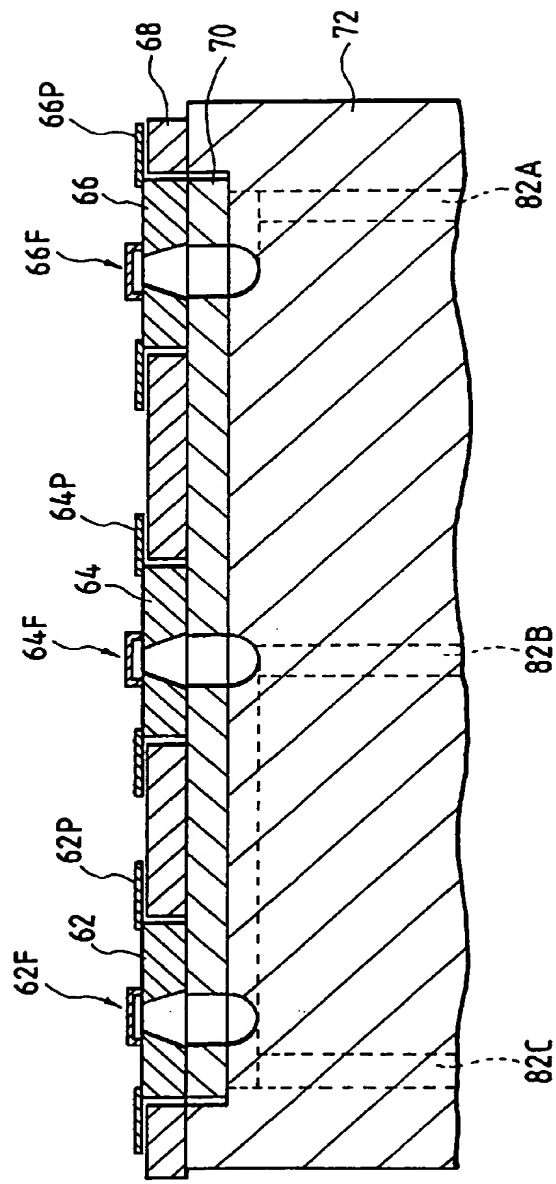

L
62F
62Fa
62
62P
62K
62Ka
64F
64
64P
64K
64Ka
66F
66
66P
66K
66Ka
68
68a
68b
68c
70
70a
70b
70c
72
72G
72G
72S
W
82A
82B
82C

FIG. 20



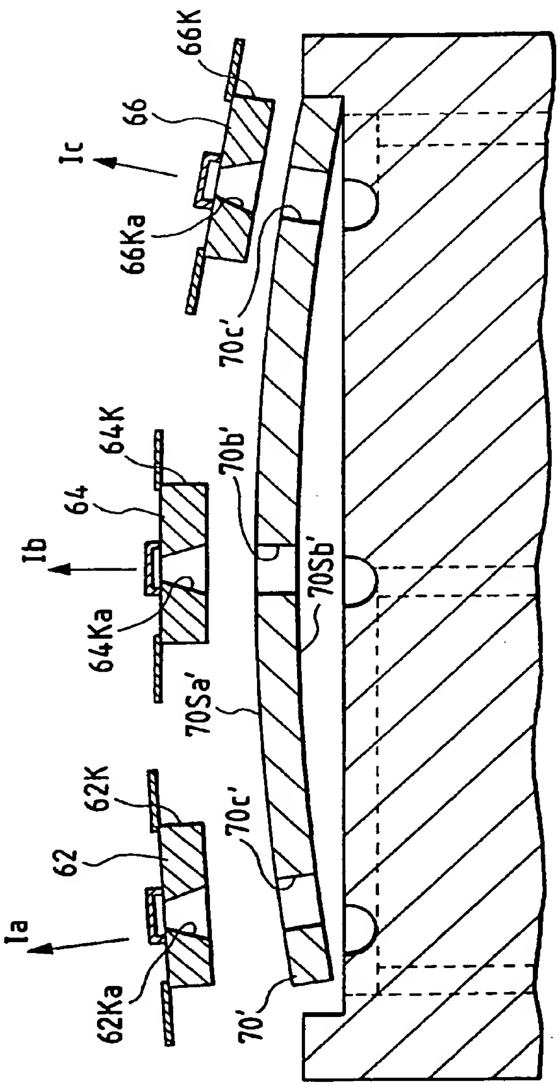

Ia
62Ka
62
62K
70'
70c'
70Sa'
64Ka
64
64K
Ib
70Sb'
70b'
70c'
66Ka
66
66K
Ic

FIG. 21

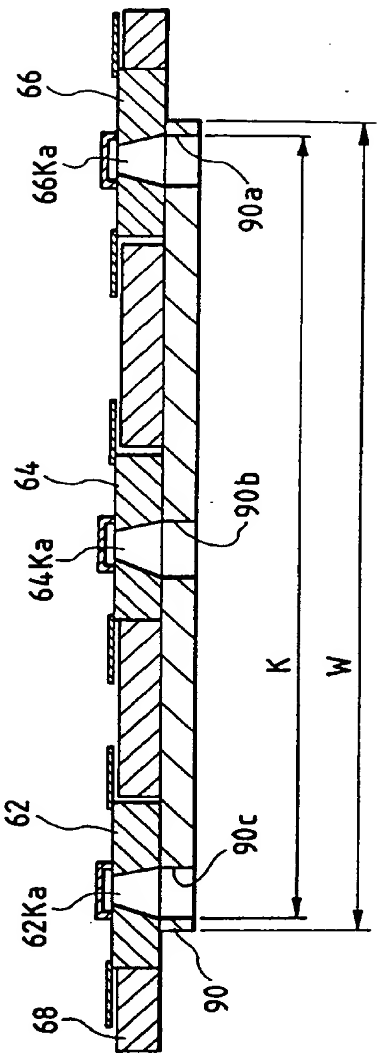

68
62Ka
62
90
90c
64Ka
64
90b
66Ka
66
90a
K
W

FIG. 22

FIG. 23

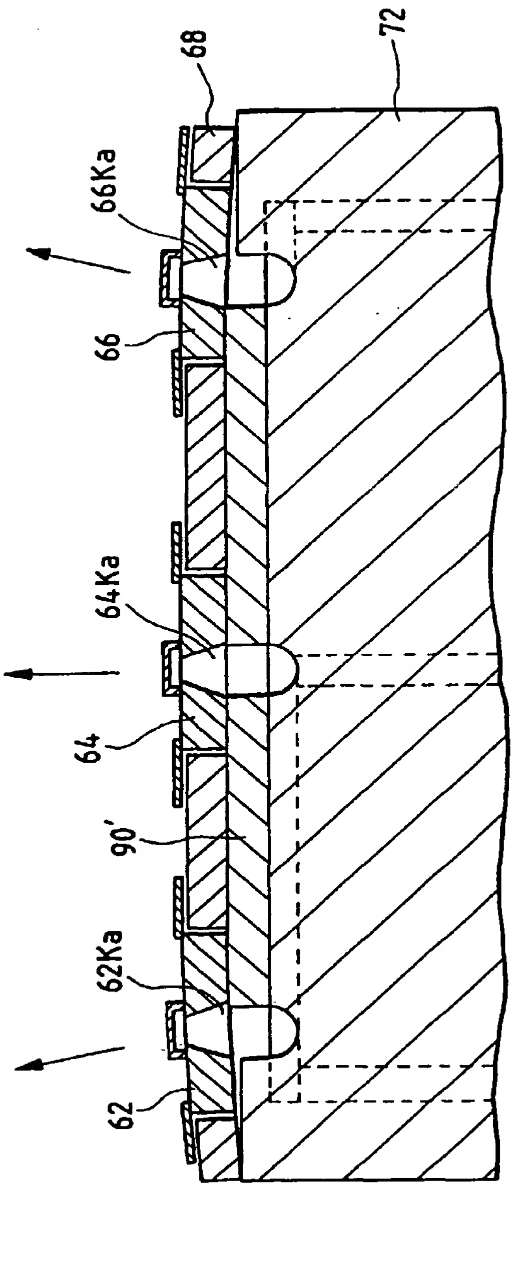


FIG. 24

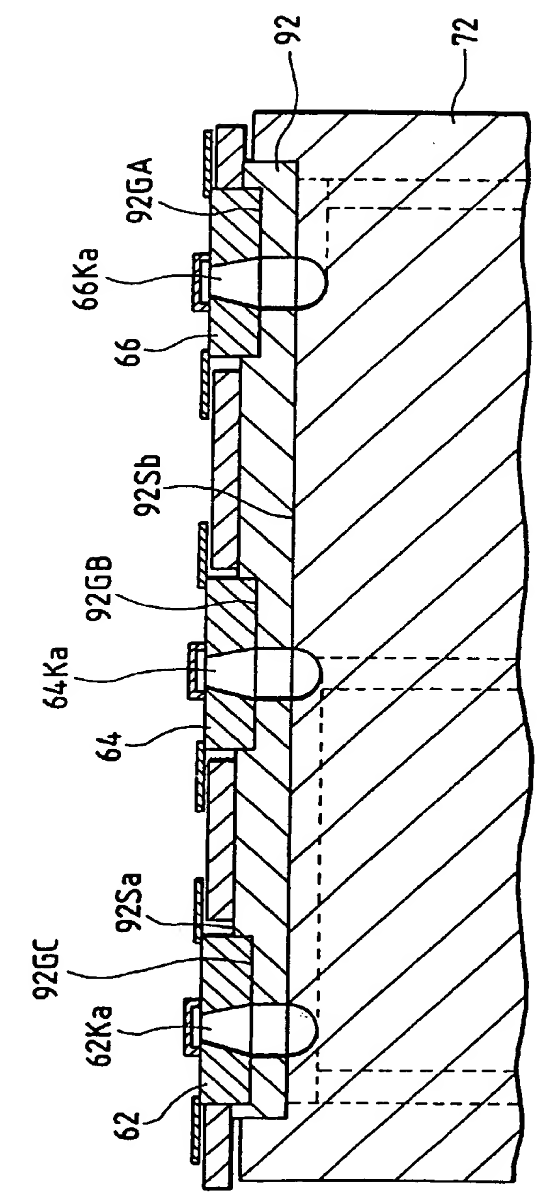


FIG. 25

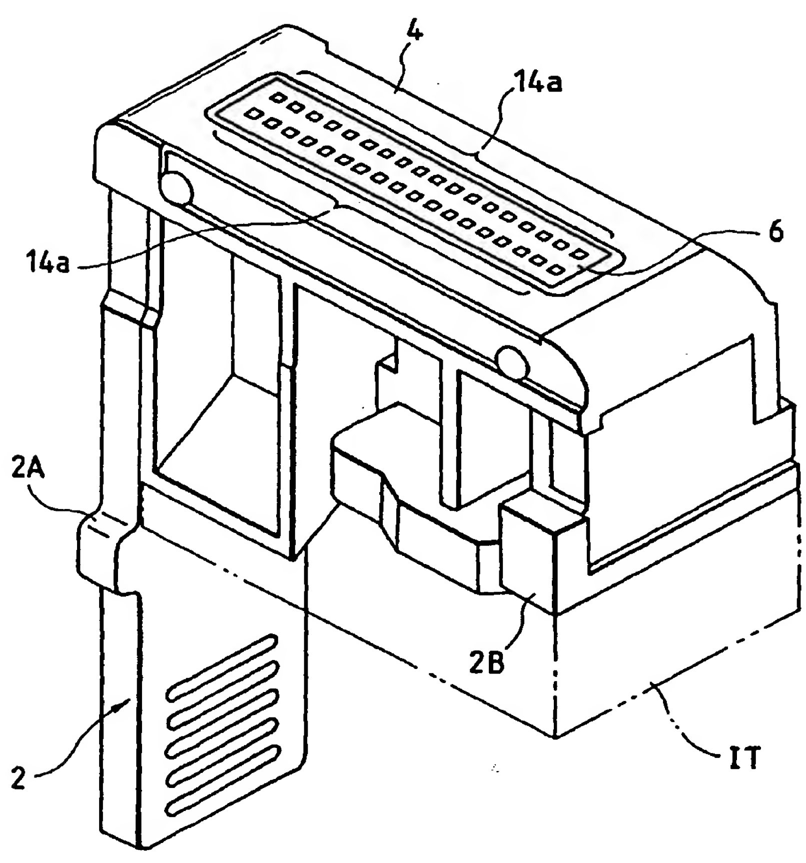


FIG. 26A

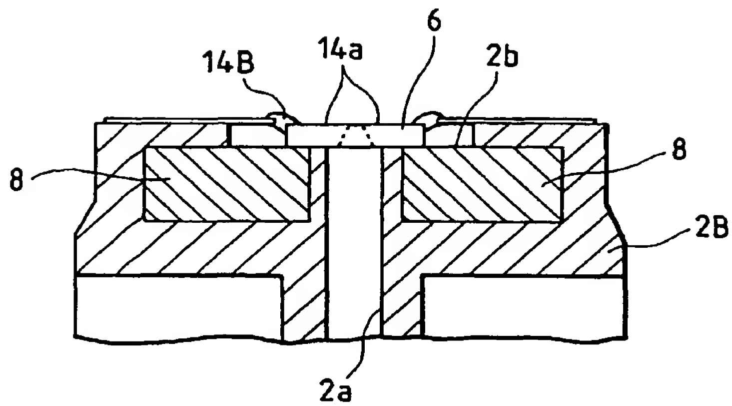


FIG. 26B

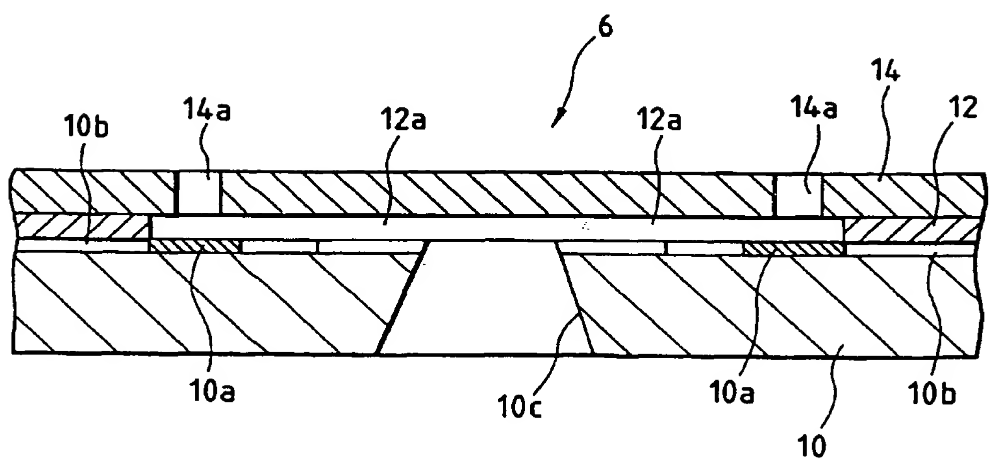


FIG. 27A

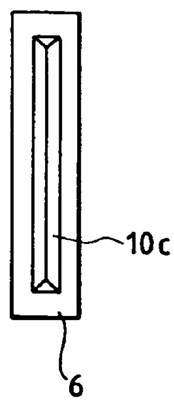


FIG. 27B

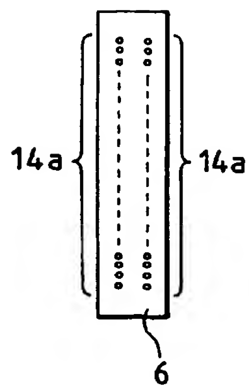


FIG. 28

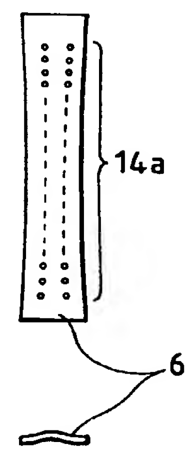


FIG. 29

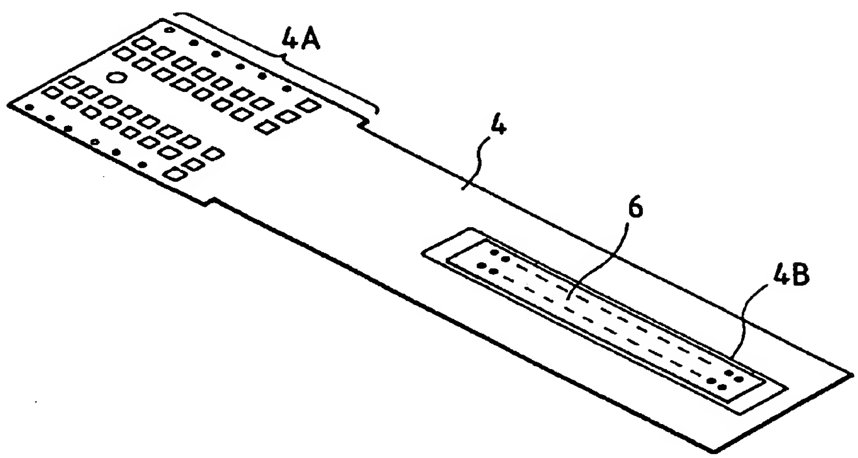


FIG. 30

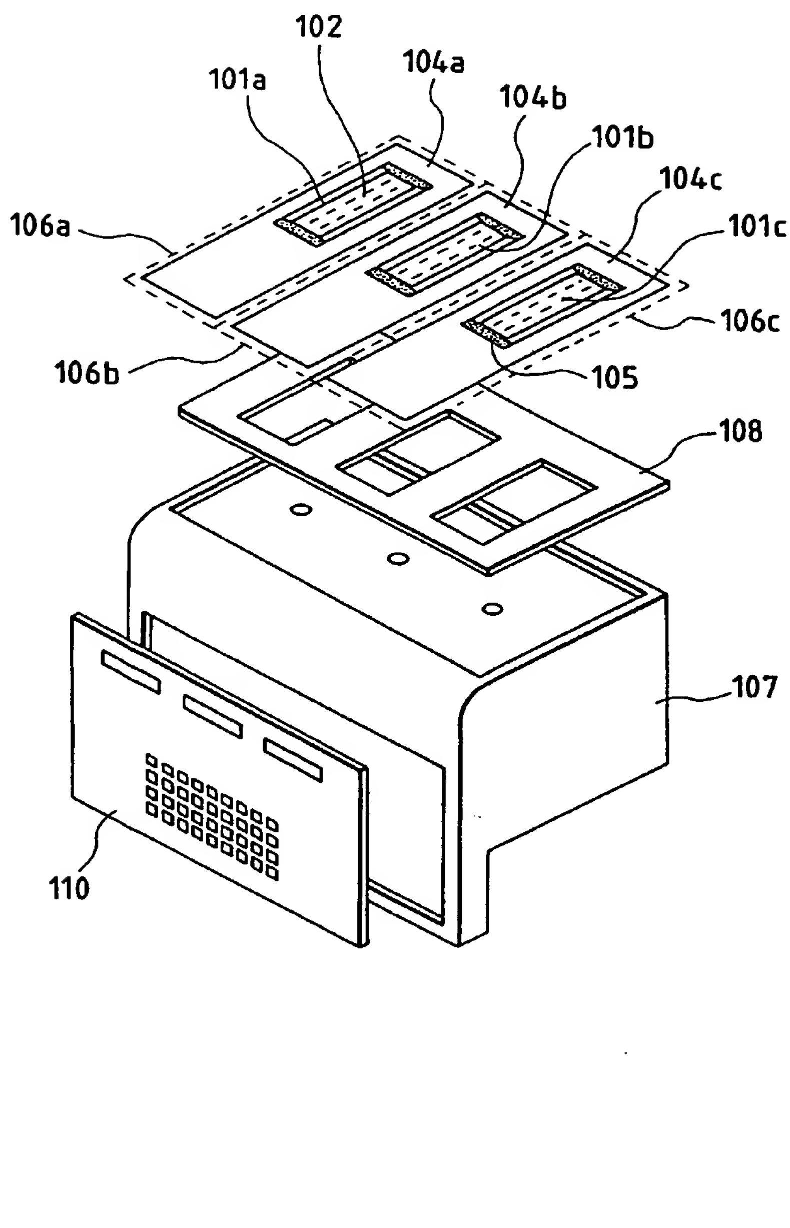

102
104a
101a
104b
101b
104c
106a
101c
106c
106b
105
108
107
110

FIG. 31A

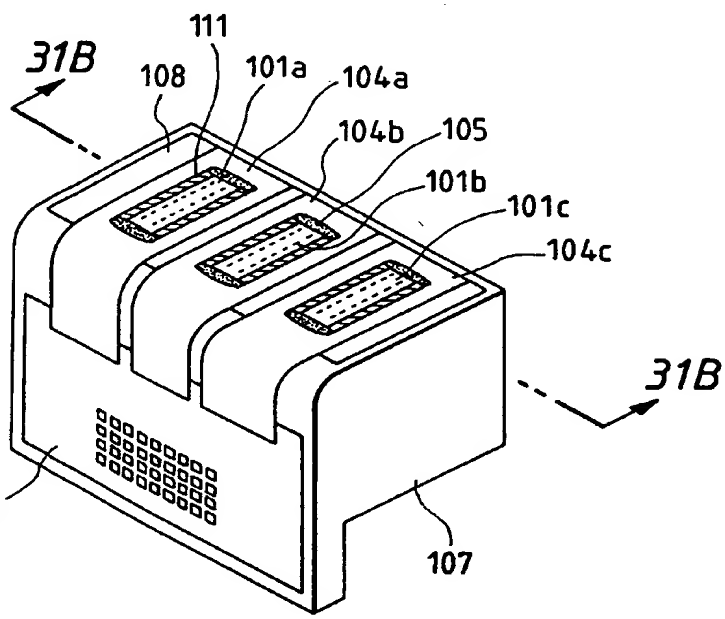


FIG. 31B

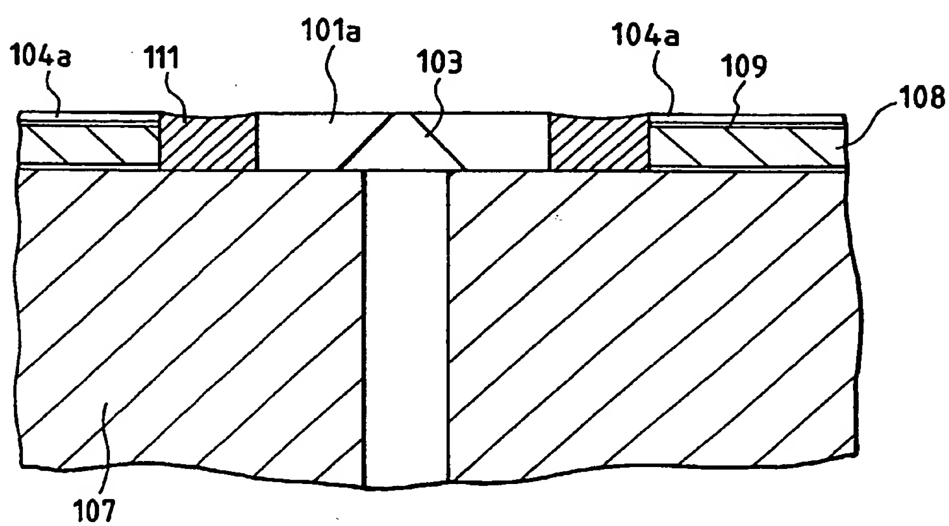


FIG. 32

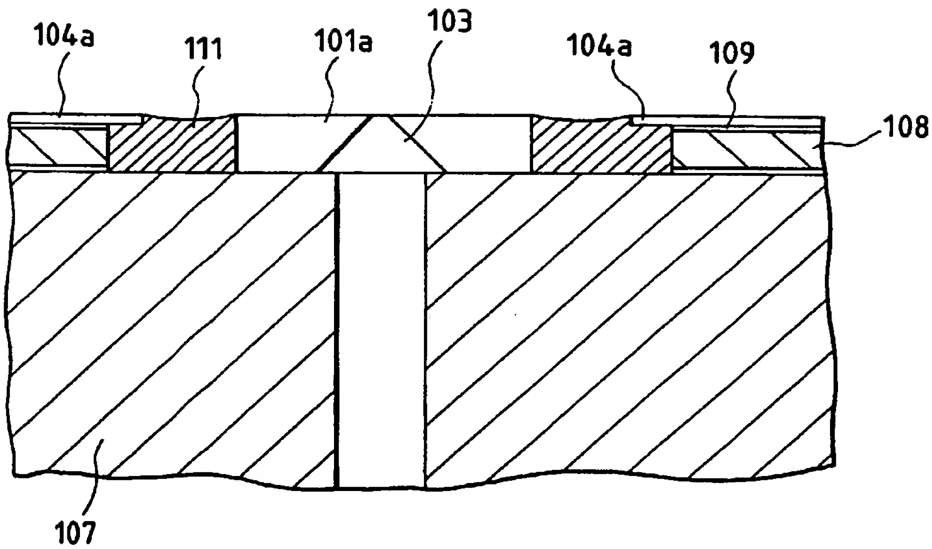


FIG. 33A

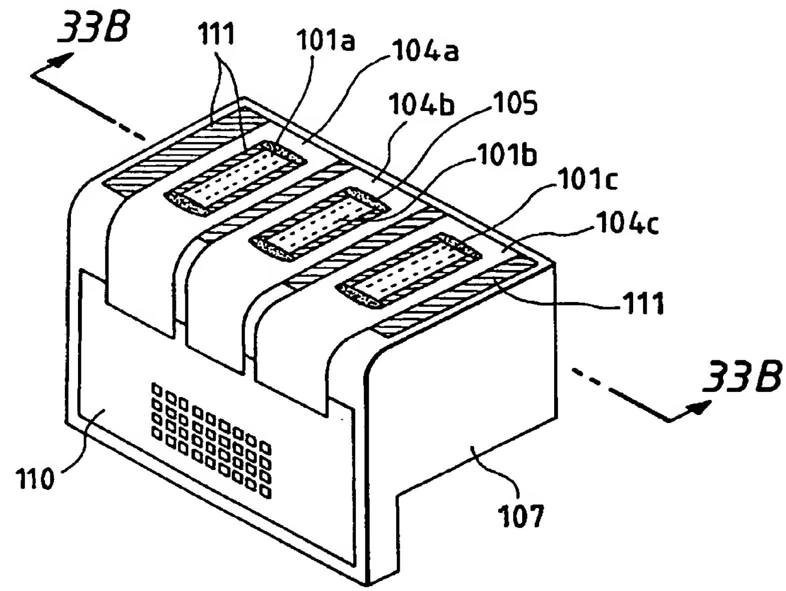


FIG. 33B

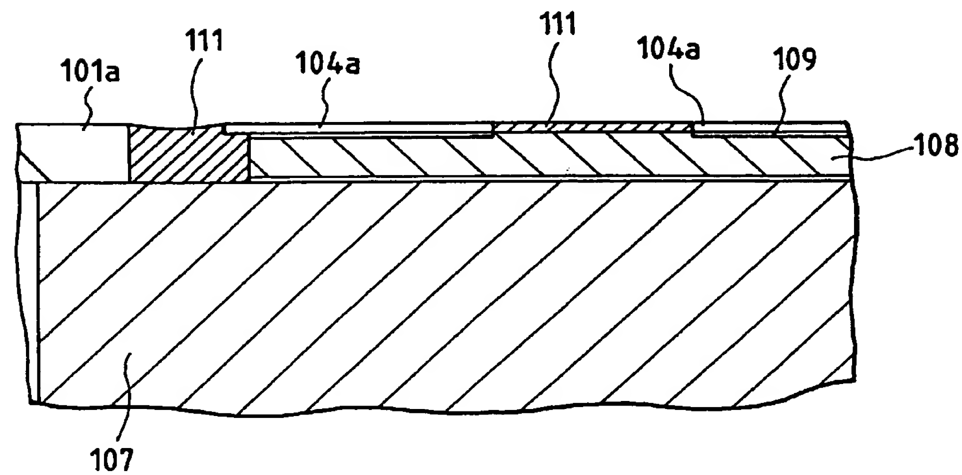


FIG. 34

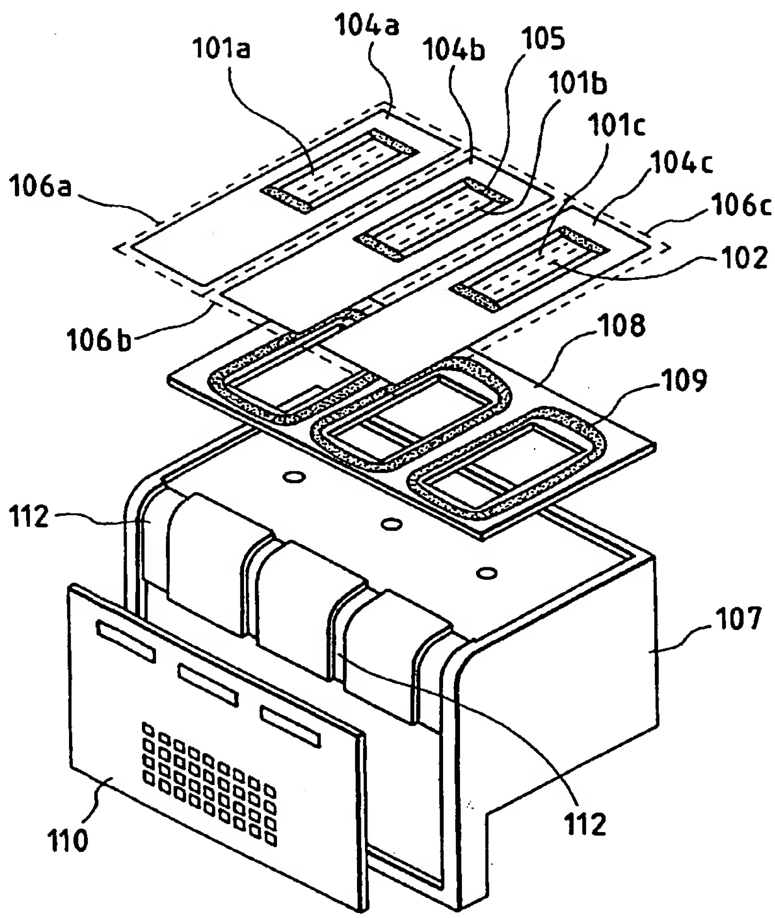

101a
104a
104b
105
101b
101c
104c
106c
106a
102
106b
108
109
112
107
112
110

FIG. 35A

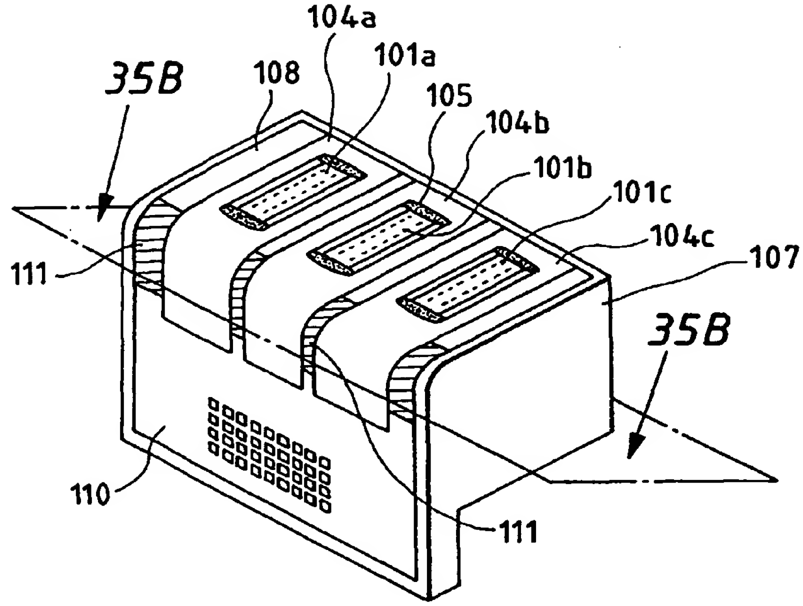


FIG. 35B

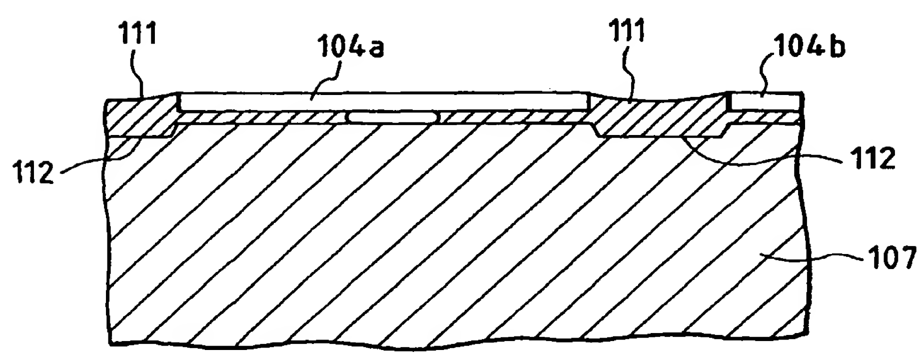


FIG. 36

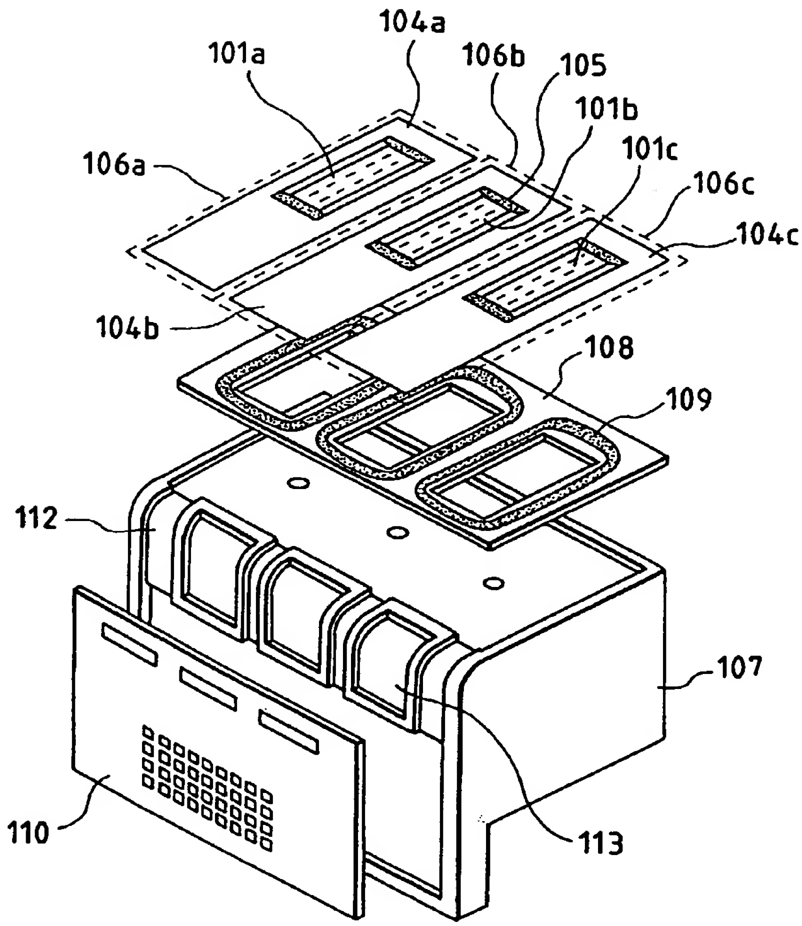

104a
101a
106b
105
101b
101c
106a
106c
104c
104b
108
109
112
107
110
113

FIG. 37A

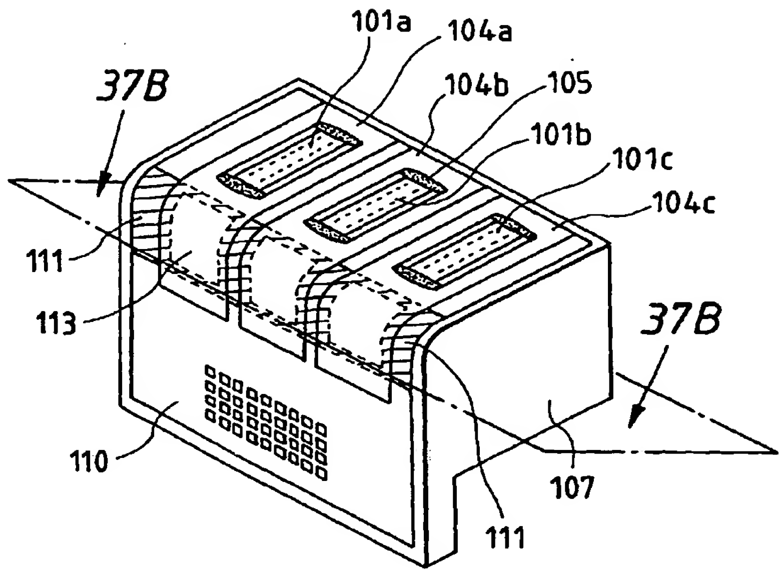


FIG. 37B

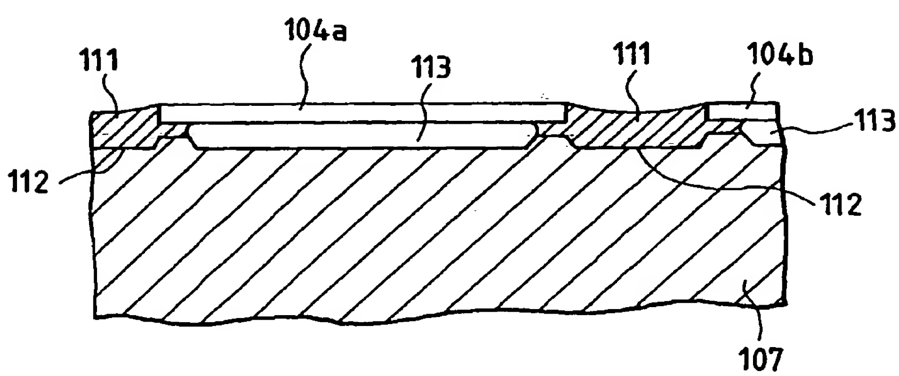


FIG. 38A

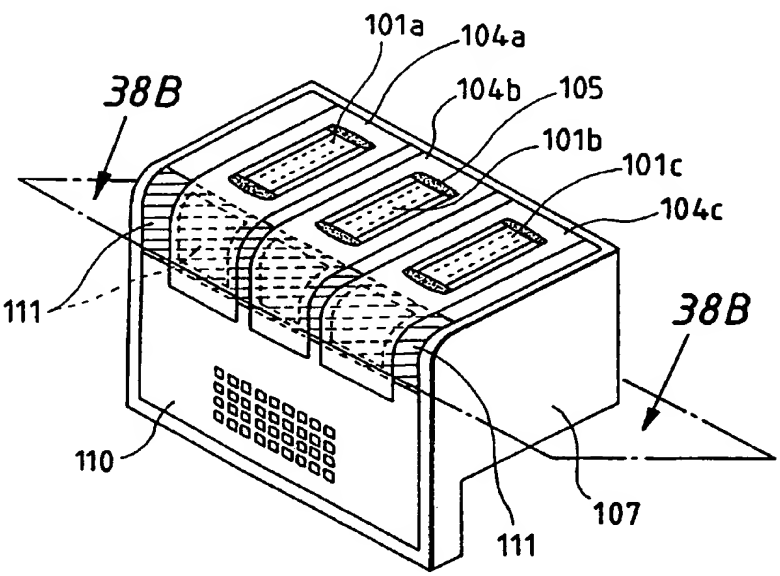


FIG. 38B

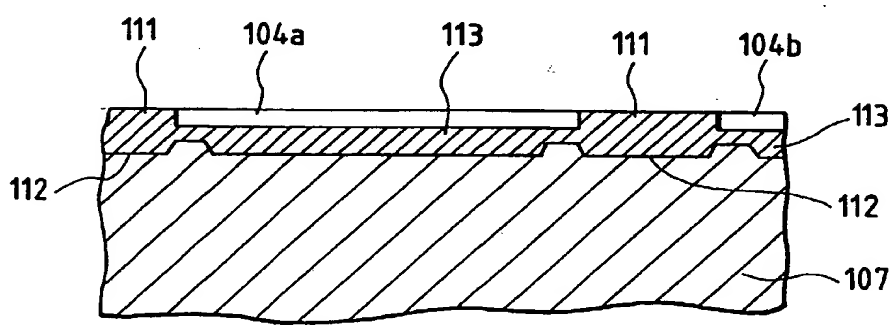


FIG. 39A

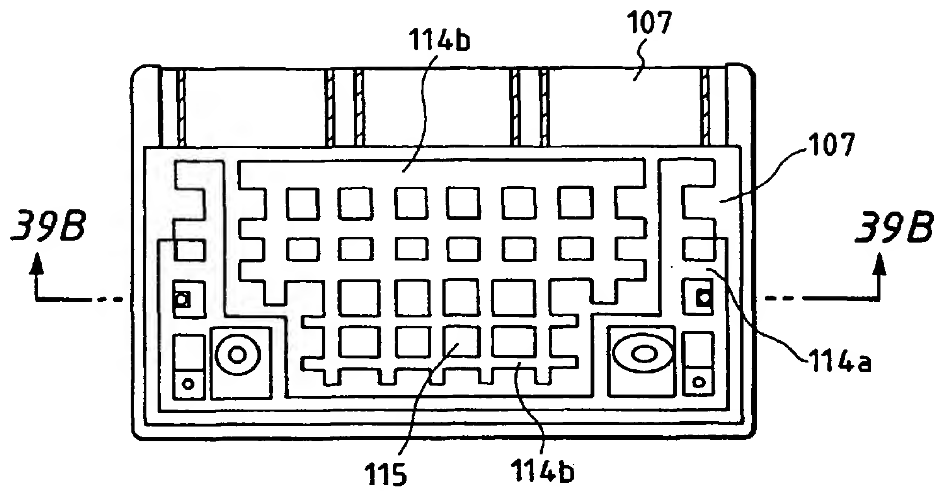


FIG. 39B

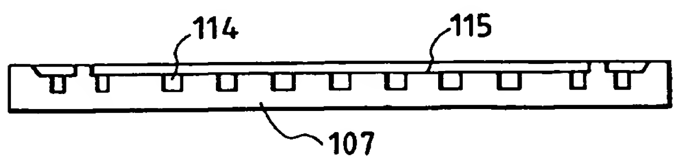


FIG. 39C

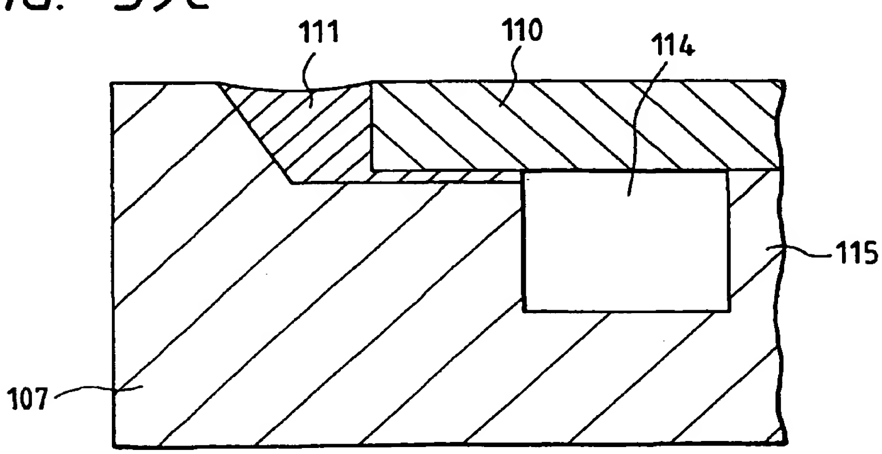


FIG. 40

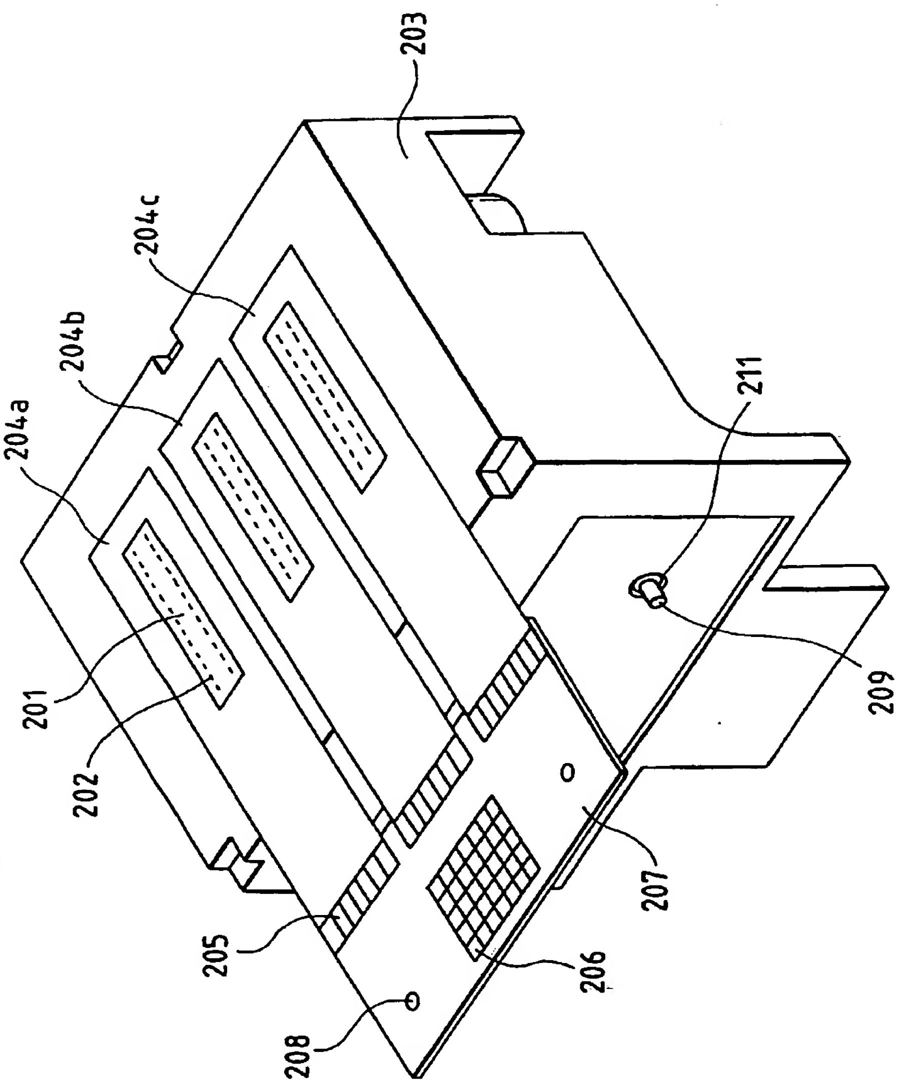


FIG. 41

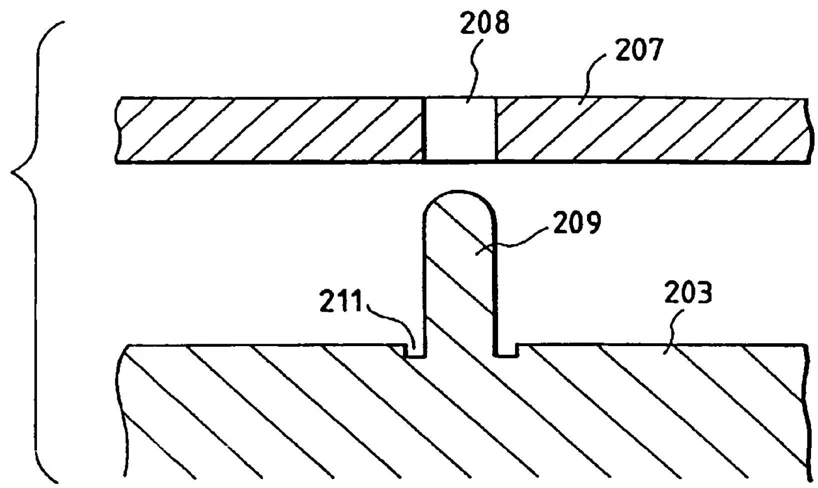


FIG. 42

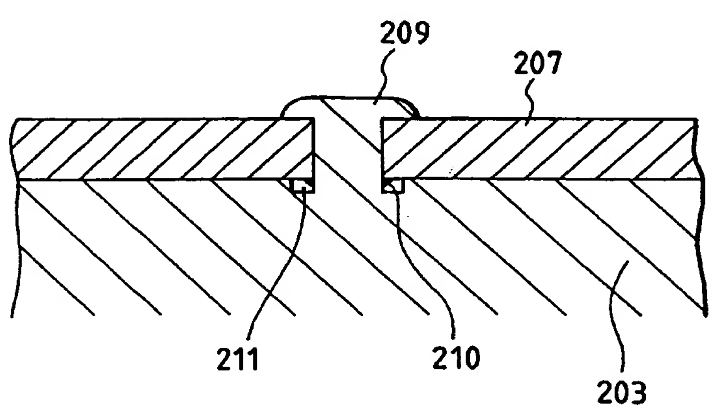


FIG. 43

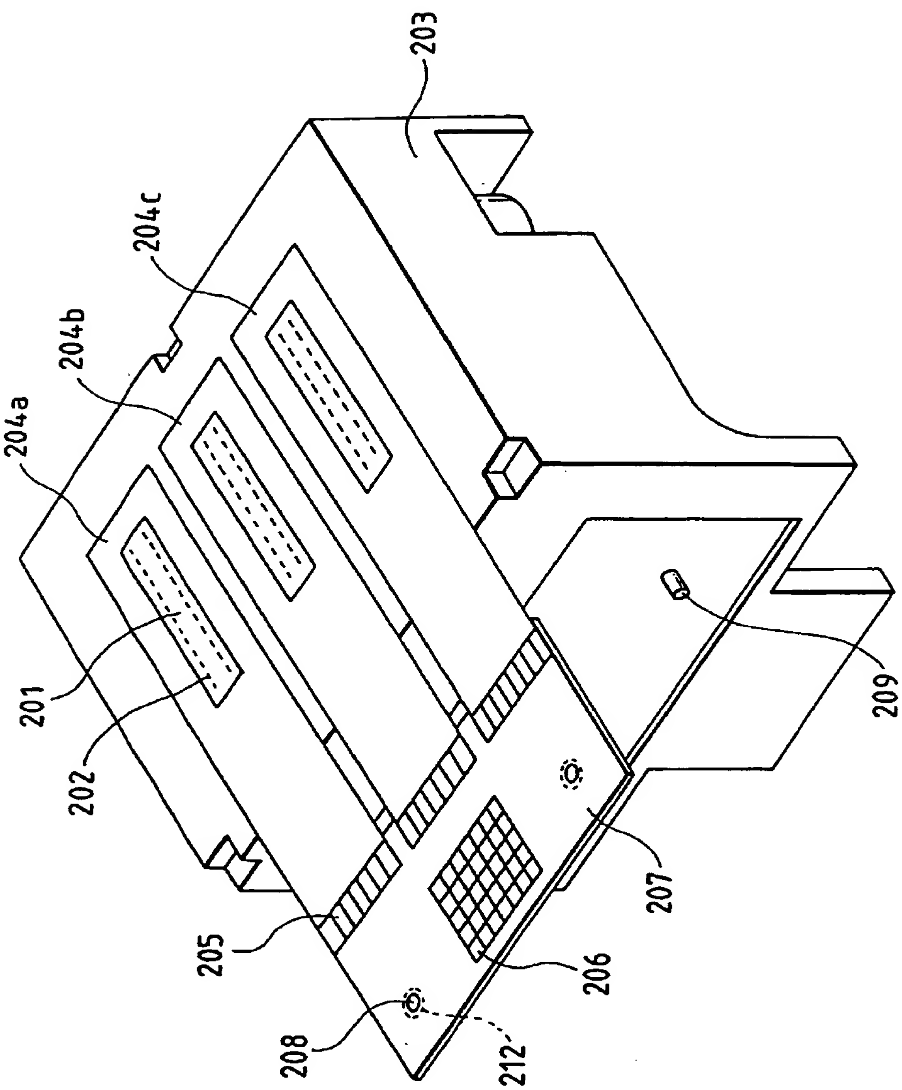


FIG. 44

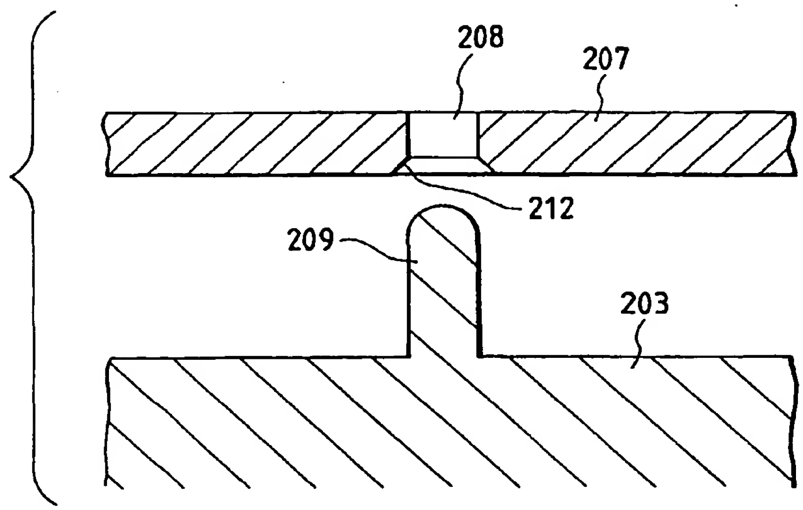
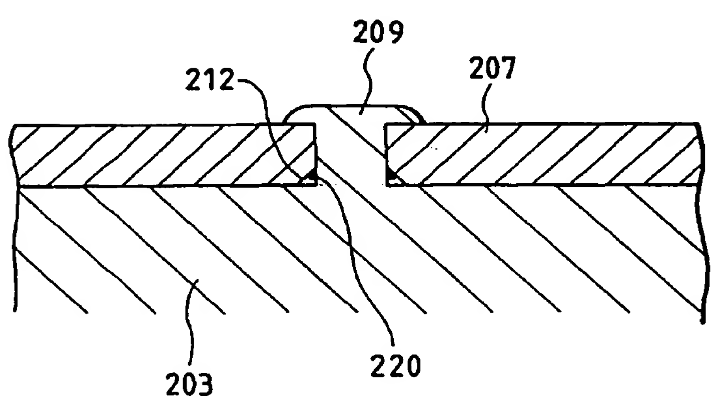


FIG. 45



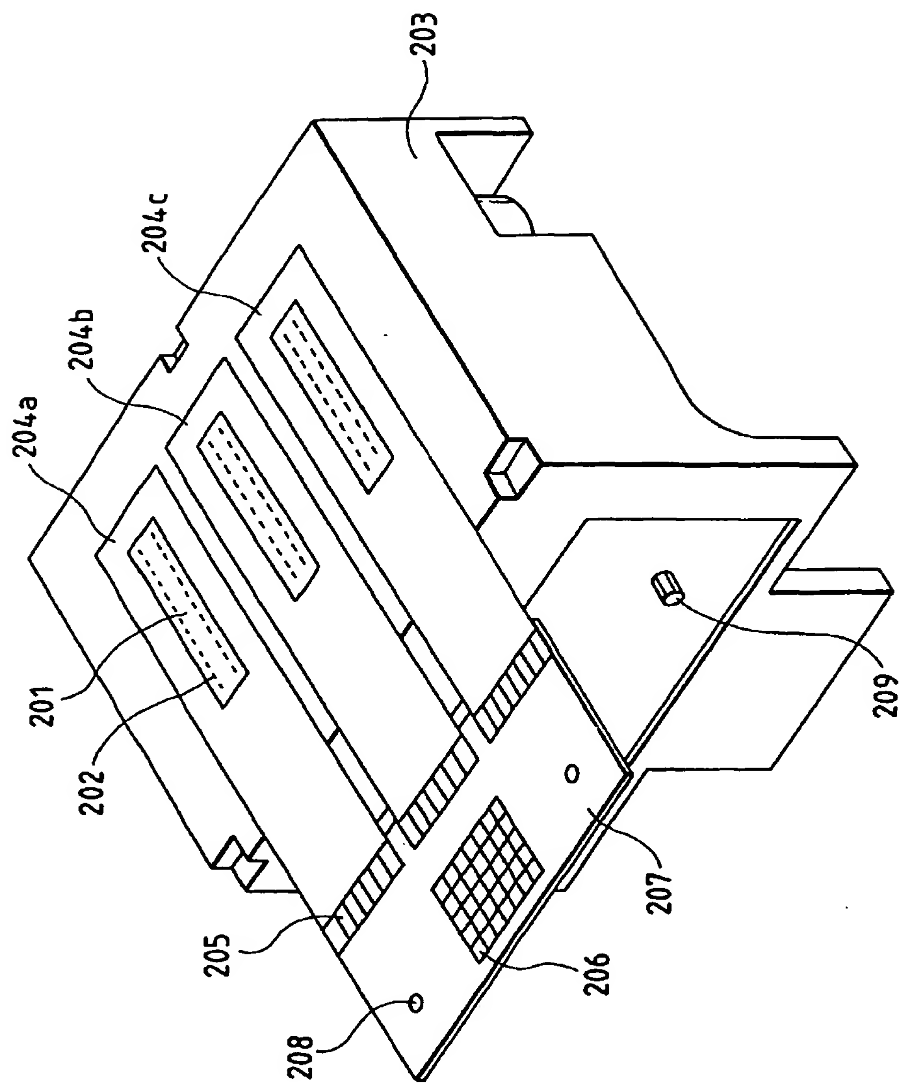


FIG. 46

FIG. 47

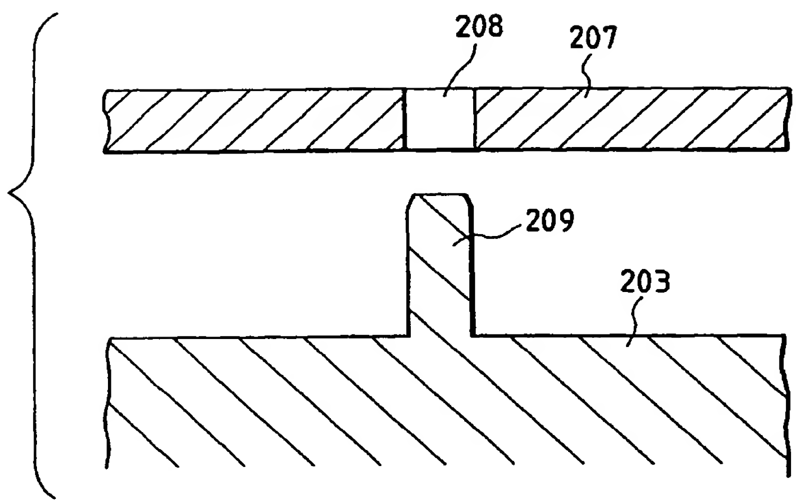


FIG. 48

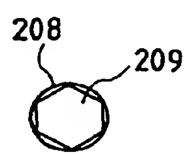


FIG. 49

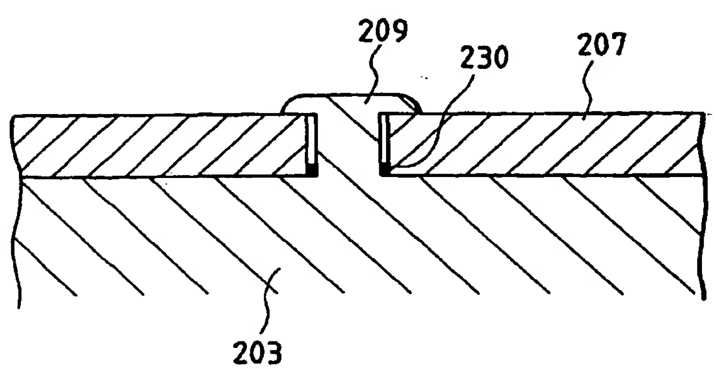


FIG. 50

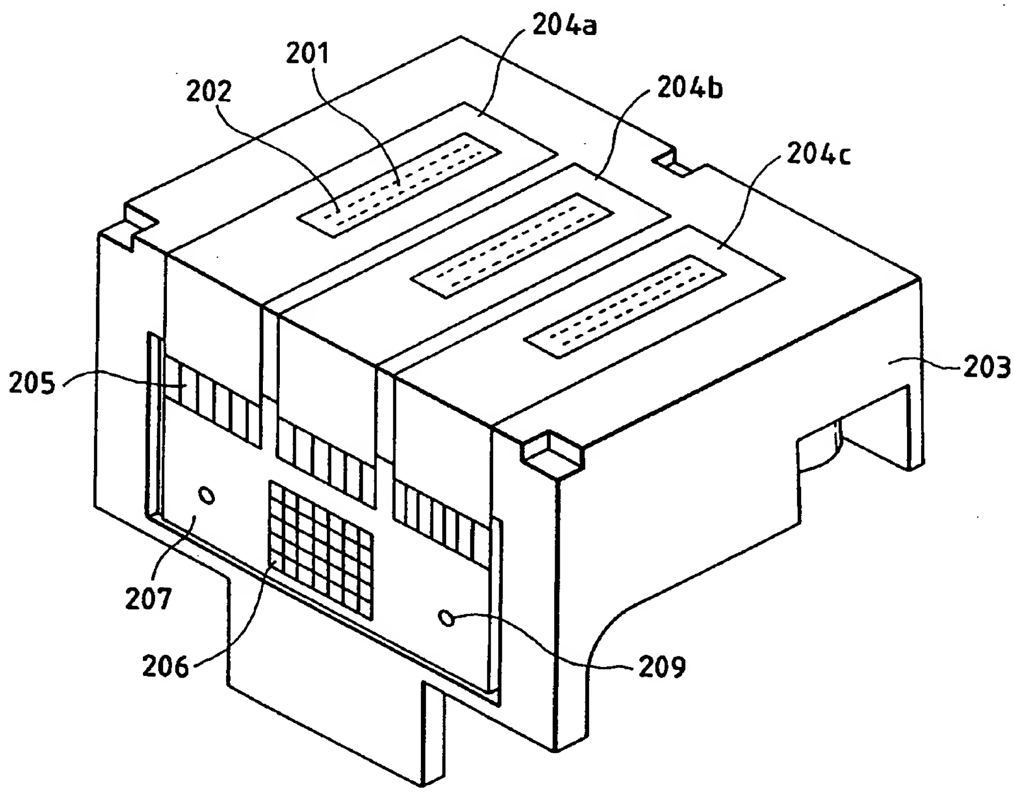


FIG. 51